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An American volunteer battery on a practice hike

MOTORCYCLE_MACHINE GUN BATTERIES [See page 72]

Conditions of the Moon*

Has It Passed Through a Glacial Period?

By P. H. Puiseux

THE interest which attaches to the study of our satellite has for its chief object the hope of interpreting the features of its surface. These features are remarkably clear, suggestive, full of vigorous contrasts; but they convey general impressions. No telescope details them exactly to our liking. We should like to know what would be our sensations, our experiences, if we could be permitted to examine them much closer.

In order to reply to the question at the head of this paper the ancients relied upon the most accommodating expedient: to consider the Moon as an image or copy of the Earth. The philosophers whose opinions are quoted for us by Plutarch and Seneca believed that the "star of night" possessed seas, mountains, forests, towns, inhabitants. And, to tell the truth, one could not raise any very grave objection to this belief, seeing that they had to guide them only observations made with the naked eye.

Astronomy of position has been able to furnish a certain amount of support to this same belief by comparing the distance of the Moon with the distances which separate us from the Sun and the planets. The proportion is so small that it is difficult not to regard the Moon as a direct dependent, as a fragment hardly detached from the Earth.

But the improvement of telescopes has acted in an opposite sense, in showing that the lunar landscape is quite different from the terrestrial landscape. An astronomer familiar with the subject, shown a total or partial photograph of the Moon, will recognize its origin without hesitation. For possibility of confusion with a terrestrial subject to arise, it is necessary to choose a limited and quite exceptional site on the Moon.

The ancient opinion has not, however, lost all its force. Many observers have believed that they have seen in the Moon: with Riccioli, seas; with Cassini, clouds; with Sir William Herschel, active volcanoes; with Schröter, fortifications; with Gruithuisen, intentional geometrical figures; with Pickering, spaces covered with vegetation.

It is generally admitted today that these attempts have not been crowned with success. The observations are numerous and reported in good faith, but discordant, and it has not been possible to weld them into a coherent whole.

So many unfortunate experiences invite us to follow a more circumspect method. Is it necessary to accept to the letter the counsel of the great physiologist, Magendie, declaring that in face of the phenomena of life, the attitude of the investigator must not be that of a theorist or a prophet, but, rather, that of a humble rag-picker? That the facts must be collected patiently over a long period of time, until one of them suggests in a forcible manner a verifiable hypothesis?

That would be perhaps to postpone the solution for a long time. The rag-picker himself does not gather indiscriminately. Before he sets out he knows what it will pay him best to gather. Experience guides his investigations and his result. We shall augment our chances of interpreting correctly the features of the Moon if we have at first acquired a general knowledge of the history of the Earth, and a more intimate knowledge of certain chapters of that history, because life is short, and it is not necessary to embrace all.

That done, we should be able to imagine rather well what would be the aspect of our globe for an observer transported to the distance of fifty to sixty terrestrial radii. The permanent features whose characteristics are most clearly observed in these conditions will be those which it will be interesting to investigate on the Moon. We shall thus have a point of departure more sure than the fortuitous and fugitive appearances glimpsed in the telescope.

Our imaginary observer will see a great part of the Earth veiled by clouds, but this curtain would very soon betray, by its mobility, an atmospheric origin. With a little patience he would be able to pick out the permanent features which bound the spaces occupied respectively by water, vegetation, uncovered soil, and ice. Great progress would at once be made if we could manage to divide the visible hemisphere of the Moon into four clear categories such as these.

As regards the Earth, water obviously predominates by a long way, but the three other elements are by no means negligible, and it is with the last-named only, ice, that we shall occupy ourselves today.

Let us return to our imaginary observer, and suppose him placed before the Earth, equipped with an instrument which will permit him to distinguish details of a kilometer or more in extent, with a little contrast. His position must not be too far from the terrestrial Equator in order that his view may reach all latitudes. These conditions are nearly those which a good telescope permits us to realize in regard to the Moon. Our observer will be able to establish without much trouble the existence of white spots, clearly defined, but somewhat variable and irregular, each being reduced to a minimum in the warm season. The most important of these spots covers the environs of the South Pole. Another, of lesser extent, but still considerable, clothes the neighborhood of the North Pole and Greenland. A rather large number of similar spots, much smaller, are scattered all over the place, even as far as the low latitudes. They correspond to Alaska, Scandinavia, New Zealand, the Himalayas, the Caucasus, the Alps, and to Ruwenzore in Equatorial Africa. They are so many groups of glaciers. Since sufficient altitude and humidity occur here at one and the same time the summits of the mountains invite the precipitation of snow. The annual fall exceeds that which the Sun is able to melt. The snow thickens under its own weight, is transformed into ice, and flows off slowly over the slopes, sending branches down to the sea, or to the regions of milder temperature and rich vegetation.

Glaciers represent considerable masses, capable of important mechanical work. They wear away the asperities of their bed, and widen the valleys which they descend. But they chiefly act indirectly by forming a barrier across the valleys which they meet. The waters accumulate in amount. When the glacier retreats, the dam yields under pressure, and a sudden break-up ensues; the valley is stripped and deepened far beyond one's ordinary realization. Thus is explained the disproportion, frequently demonstrated in mountainous countries, between torrents and the valleys which they traverse.

Another office of glaciers is the transport of boulders broken off the mountain sides. The footings of the mountains are thus being constantly eroded, which permits them to acquire those bold and slender forms so admired by tourists. No charge is too heavy for the glacier. It transports the largest boulders without stoppage with a speed which can reach one hundred meters per annum, and throw or divert them on to its flanks, on its terminal slope, or into the sea. When the glacier is decreasing, each halting-place of the retreat is marked by the deposition of a dike or dam, called a "moraine" in the region of the Alps. These moraines can become, with time, veritable mountains. But even when they are abandoned by the glaciers and invaded by vegetation, their structure and mineralogical composition reveal them as foreign importations, without roots in the soil which carries them. An informed observer can thus recognize that glaciers have existed in the regions which exhibit today no apparent vestige of them. It is in this way that the currents flowing from the summits of the Alps have deposited masses of crystalline rocks (erratic blocks) in northern Italy, on the Swiss plain, on the slopes of Jura, and as far as the neighborhood of Lyons, respecting the origin of which no reasonable doubt can be raised today.

In order to explain what has just been said, I put before you some examples of terrestrial glaciers, preferably general or distant views, in order that we may approach the conditions in which astronomical work must be effected.

By their extent, their thickness, their aptitude to reflect light, glaciers are eminently apt to catch the eye. The existing glaciers on the Pyrenees are but the feeble remains of what they have been in the past. Nevertheless, attached to the flank of some lunar mountain, one can affirm that they would not be difficult to discover. If the phenomenon had in former times acquired on the Moon the same development as in Scandinavia or the Himalayas, its traces would still be rather striking, the conditions of persistence appearing much more favorable on the Moon.

One will judge, perhaps, *à priori*, that the chances of success in the search for glaciers on the Moon are *nil*. For certain authors the Moon is condemned, owing to the absence of atmosphere, to a temperature always very low. It is entirely sheathed or plated with ice, and the contrast necessary for fixing the limits of glaciers is lacking. Others sustain the theory diametrically opposite; for them the dryness of the surface of the Moon is absolute; water does not persist there even in a solid form. We should find, in an aggravated form, the conditions which exist in Thibet, where mountains of twenty thousand feet or more in altitude reveal themselves entirely denuded, while the glaciers are met far lower on the warmer and much more humid meridional slopes of the Himalayas.

Finally, a third opinion, equally hostile, avers that the Moon, ill-protected by a very rare atmosphere against the fall of meteors, is covered by a complete veil of cosmic dust. One would not be able to perceive ice under this veil, nor even to distinguish moraines.

But we have the right to think that none of these extreme solutions respond to reality. To extend over the whole of the Moon either ice or meteoritic *débris* is to stand condemned of being unable to explain the very obvious contrasts of tint which exist between neighboring regions, the ones having the power to polarize light, while the others are deprived of that power. A continuous mantle of ice would of necessity melt, at least partially, and under the Equator, under the prolonged action of the solar rays, and one cannot see how sheets of water thus formed could escape us. To deny all liquefaction without satisfactory motive is to accuse the solar radiation of impotence, whereas a rare atmosphere must, on the contrary, favor solar radiation. It may be that one meets on the Moon with conditions adverse—still more adverse than those of Thibet—to the formation of deposits of ice, but it remains to be proved that these conditions are universal and that they have always been the same in the past.

Some positive signs are, in other respects, encouraging. It is not admissible that the elements of water, so abundant on the Earth, have always been wanting on the Moon. Actinometrical measures demonstrate for the Equatorial region a variation of temperature which, without any doubt at all, extends, very far on both sides of the melting-point of ice. The two Polar regions of the Moon, reached with difficulty by the solar rays, even deprived of those rays in their deepest parts, cannot avoid being always very cold, and thus form energetic condensers for all the vapors liberated in the lowest latitudes. If we do not observe regular change of aspect with the phase, it is because the condensation is apparently definitive, and that it has taken effect on all that it could reach.

Altogether, the prognostic is rather favorable. The research merits attention, and it is in the Polar regions that it offers the best prospects of success. I shall ask you to examine with me a series of lunar photographs from the Observatory of Paris, so that you may form your own opinion in this regard. A judicious selection of these documents is realized in the photographic and systematic chart of the Moon by M. Le Morvan. The twenty-four plates already published in this collection will suffice for our object.

In commencing with the North Polar region, we see that the differences of level there are pronounced and abrupt, even in the immediate neighborhood of the North Pole itself. If there has been any accumulation of ice there, it has not been sufficiently abundant to weaken the relief sensibly. There is no difference in this regard between the slopes exposed to the Sun and those which are turned away from it. One seeks in vain for a clearly-defined limit separating the ice-cap from the zones of lower latitude free from ice. Outbreaks of whiteness, which are produced in places, for example, on the plateau of the Alps, are evidently under the influence of local causes, due neither to altitude nor to climate.

The rugged structure of the plateau of the Alps exhibits no system of fluvial valleys. When a furrow is seen it has the character of a fracture, obstructed or contracted at its two extremities, without propensity to widen without opening on to the plain.

The great hill-groups which dominate the seas would have offered admirable sites for the development of glaciers. But their bases—for example, round the Sinus Iridum—have the aspect of abrupt escarpments, without anything resembling alluvial deposits or morainic edges. It is not the mountain which has scattered its material on the sea; it is, on the contrary, the sea which has eroded and undermined the mountain. The environs of Fontenelle and Mairan are significant in this respect.

To sum up, there is no sign of an actual ice-cap nor of the abundant passage of water which would of necessity accompany the melting of an old cap.

*An address delivered to the Astronomical Society of France in January, 1916, published in the official *Bulletin* of that society. From a translation in the *English Mechanic*.

The neighborhood of the South Pole provides analogous observations. The interior slopes of Blancanus. Tycho, Calvius, Longomontanus, are steep, and present enormous differences of level (more than 15,000 feet). Glaciers working in such conditions would have effected an intense mechanical work, would have destroyed the floors and terraces, and would have communicated a different aspect to the northern and southern slopes.

It is necessary to descend into lower latitudes to find mountain masses, well isolated, with pronounced slopes. White spots, such as that in Descartes, are not rare there, but they neither frequent elevated points nor the parts sheltered from the Sun, and have little effect on the relief of the surface. Nothing in their appearance recalls the known behavior of a glacier. The white spot of Linné, situated in the open plain, and considered by Prof. W. H. Pickering as a deposit of hoar-frost, variable during the course of an eclipse, does not exhibit variation periodic with the phase, and must rather be regarded as a permanent volcanic deposit. Even with feeble development, glaciers situated on the eastern slopes of the Apennines would have destroyed by friction or by sedimentation the transverse crevasses which we can see extending across the Mare Imbrium parallel to the boundary of the mountain masses. The valleys of Rheita and Piccolomini are intersected by numerous partitions, which would have been ruptured by even the weakest circulation of water. The dark borders of the Mare Serenitatis of Julius Cæsar, would be capable of interpretation as indicating the persistence of a source of humidity at the foot of the mountains. But a more likely explanation may be found in the expansion and bulging of the depressed surface, brought in contact with the warmer layers of the planet and restrained in its lateral expansion.

We have not been more fortunate in searching either for white spots or for traces of glacial erosions on the interior floors, sheltered from the Sun, of the great formations Petavius and Langrenus. The floors of Hevelius, Mersenne and Vieta have a manifest convexity, explicable by expansion. Glaciers clothing the interior slopes would have operated in an opposite manner by filling up the peripheric portion of the floors. The well-known halos of Lanlande, Copernicus, Kepler and Aristarchus are too independent of the relief of the surface to be considered as snow deposits. The persistence of the long clefts of Sirsalis, traced across an elevated plateau, compels us to relegate the problematic existence of glaciers to a more remote past. Beds of glaciers formed on the exterior slopes of Aristotle and Copernicus would have been forcibly contracted toward their extremities. The furrows visible on these declivities do not disclose any such contraction.

Finally, there would remain the expedient of considering the ridges which run at many points across the *maria* as frontal moraines, corresponding to the maximum extension of a glacier. In general, these ridges follow the general contour of the mountainous border which surrounds the sea, but they branch readily, like crevasses formed by the action of a prolonged effort under a heterogeneous crust. Their direction is much more regular, less broken, than that of the border, and it is constantly convex thereto. Frontal moraines would have been obliged, on the contrary, to throw out promontories toward the center of the sea and to reproduce, in an inverse sense, with exaggeration, the sinuosities of the border being concave, instead of convex, thereto. The pronounced preference of small craterlets for the ridges compels us to consider the ridges as indicating the site of deep crevasses formed by forces acting from the interior, and afterward used for the discharge of lava. Here, again, the glacial origin has to be set aside.

There may be seen between Gambart, Landsberg and Fra Mauro, a striated and rocky region which would very easily pass for a glacier bed. But here, precisely, the circle of alimentation is wanting, as well as the frontal moraine, and the latitude is particularly unfavorable.

After what we have said of the necessary presence of the elements of water in the lunar globe, this universal, immemorial dryness demands an explanation. This is what I suggest in default of a better explanation.

In consequence of the feebleness of gravity on the Moon, discharges of matter to the surface have been particularly free and abundant. During the whole period of formation of the circles, and during the series of volcanic eruptions which have followed, the Moon has prodigally expended its internal heat, without allowing snow deposits or sheets of water to form. When the soil has set, the later eruptions which have given birth to the divergent light-ray systems have emitted such a quantity of ashes that these ashes have been able to absorb all the water which happened to be at liberty, and even that which appeared later. A rapid and general cooling has afterward fixed the water of the lower strata, and the action of the solar rays, penetrating but little, can only manage to liberate at each sidereal revolution the humidity from a thin layer.

We shall arrest our exploration here. It could be prolonged, I believe, without eliciting any serious indication in favor of the presence of glaciers on the Moon. If they have been there in the past, they have not survived the volcanic period, and even their traces have perished. All that we can concede to our satellite at present would be banks of ice sheltered in the formations of the Polar regions, screened from the heat of the Sun, but incapable of creating around them the song of flowing waters, and the joyous awakening of life.

It is with regret that I submit for your assent this negative conclusion. It might have been agreeable to think that terrestrial analogy would enable us to decipher a few pages in the great book of the sky. But the rights of truth surpass all. If our nearest neighbor resembles us so slightly, it would be vain to hope that the more distant planets, or the stars, may reserve for us an easier task. We must not cease, however, to analyze with curiosity those frail messengers from space, rays of light. But if we are wise, we shall not depreciate, by comparison with worlds so little known to us, the globe upon which we live; and we shall keep better our affection for that great country which is the first offered to our eyes, and which, by the sacrifices which it demands as much as by the spectacles which it provides, multiplies in us the reasons for living and the power to love.

Childhood Among the Labrador Eskimo

As the child grows up, it plays at the work of its elders. The girl helps her mother around the house, or plays with her dolls[1] and miniature house and utensils. Small children are provided by admiring relatives with small ivory carvings of animals and birds, with which they play by the hour, arranging them for various plays and hunts.

The boys early receive small harpoons and bows and arrows, and try their skill on small birds and floating pieces of wood. The sling is a favorite amusement in summer, when myriads of waterfowl visit the shores. When the "young ice" forms on the shore-line, the boys delight in making a miniature boat out of one of the cakes and paddle around with a little oar, or leap from cake to cake, following the leader, or perform an impromptu song and dance on a shifting "pan." Although Eskimo children do not learn to swim, I have never heard of one of them being drowned. Their hardiness is something wonderful, perhaps due to letting them run around the iglu naked when young. I have seen them in the early spring, only a few weeks after the ice has broken up, running up and down the beach, and splashing and wading in the icy water, perfectly naked, and evidently having the times of their lives.

Football is a favorite amusement with Eskimo of all ages. The football is a small round ball made of sealskin and stuffed with reindeer hair. In Labrador, as in Greenland, it is whipped over the ice with a thong loop attached to a wooden handle. It can be caught in the air and returned with terrific force with this instrument. It is said that the Eskimo did not like to play football with the Tunnit, because they were so strong that it was dangerous. Rink gives us several stories from Labrador and Greenland of the myth hero overcoming his opponents in football.

The girls and women play handball with a larger and softer ball. A game which both sexes play is a sort of basket ball, in which the ball is thrown by the players on one side to each other, while the others endeavor to snatch the ball in the air. The women also play a sort of football "solitaire," in which they see how long they can keep the football in the air between their toes and hands, without moving from the spot.

The children play tag, and exercise in running and the Eskimo "hop, skip, and jump." They engage in imitation of the pursuits of their elders, driving each other as dogs, stalking and shooting the one who is "it" as the deer or bear or seal, as the case may be, and generally enjoying themselves as children do in all parts of the world. In one thing the Eskimo child has the advantage over white children. He is never punished. On the other hand, I have never seen an Eskimo child disobey. The feeling between children and parents appears to be one of mutual respect and goodwill. The underlying psychology seems to be sound as far as a primitive race is concerned. It probably would not work as well with white children, who are accustomed to coërcion and restraint.—*Geological Survey, Canada Anthropological Series, No. 14, By E. W. Hawkes.*

[1]Eskimo girls play their dolls are babies as white children do. They undress them and put them to bed at night, and dress them up again in the morning. During the day they carry them around in their hoods.

Pocket Stoves of Japan

By N. Kawaguchi

THE kwairo, or pocket brazier, is used by the Japanese to place in the clothing for heating purposes, and the fuel used in it is known as kwairo-bai, there being considerable rivalry as to who can invent the best fuel—a very difficult matter, since it must not emit smoke or fumes. The fuel is put up in the form of a roll like sausage, which is lighted and shoved into the small tin stove that looks something like a cigar case of metal. The fuel costs no more than 3 *rin*, or about one-third of a *sen*, and will last for three hours, giving considerable warmth to the part of the body where it may be placed. One put inside the bosom of the kimono prevents a third-class train journey from feeling too chilly. Delicate pupils keep one in their clothes while at school in winter, and so equipped anyone may sit comfortably in an unheated room. The aged and the cold-footed sleep with the kwairo at their feet Cramps or colic can be easily soothed by placing one across the pit of the stomach. In the Russo-Japanese war many a benumbed soldier saved himself by placing one in his bosom. In the present war Russia ordered a large supply for her soldiers, and immense quantities have been shipped to that country.

The excellent fuel now used in the pocket-stove was invented in 1882 by a man named Sokichi Yamazaki, of Tochigi, in the province of Shimotsuke; and a company was formed by the leading tradesmen of the town for its manufacture. As the article was left to private houses for making, the quality was not satisfactory, and so the Mayor of the town had a proper factory established in 1904, the object being to give work to widows and orphans of the Russo-Japanese war, and a trust has since been formed for the manufacture of the fuel, and the quality has been greatly improved. The annual production rose to a value of about 58,000 *yen*, but the orders from Russia have increased the trade a hundredfold. Now the output is valued at about 160,000 *yen* a year. French missionaries from Japan introduced it into France, and now there is a considerable export to that country.

Although Tochigi invented the fuel for the pocket-stove, the town has not been much heard of in the trade, as the Tokyo and Osaka merchants bought up the output, and it could only be obtained from them.

The materials from which the pocket-stove fuel is made are hemp stalks, mulberry, the *kozu* and the *catalpa* plants and a kind of vegetable oil, as well as pulverized nut rinds and corn cobs. But the best is made from hemp stalks from which the fiber has been taken. These are turned into charcoal. The method is simple. A big bundle of the hemp stalk is put in a hole in the ground like a furnace, lighted and smothered so as to smoulder without air until carbon is produced. This is pounded in a mortar. Fifty *sen* worth of raw material makes up into goods sold for 2.50 *yen*. The farmers devote spare time to this occupation, and make an extra penny. The material thus produced is sent to town to be made into rolls for the pocket-stove. As the raw material from which the fuel is made cannot be used for anything else, the profit is great, usually about 50 per cent. In the final composition of the kwairo-bai a little saltpeter is used to facilitate combustion, and, also, the leaf of a tree resembling the maple is used to stick the powder together.

Of the fuel there are two kinds, one used for the bosom-stove and the other for bed use. The former is soft, and the latter hard. The fuel has to be put into the tiny stove very carefully, as any mistake or awkwardness spoils the attempt. The fuel is enclosed in a special kind of paper, without which it will not be successful. The hard fuel is most difficult to make. The powdered carbon has to be kneaded into a paste mixed with the leaf of the tree already mentioned, and then pressed into a pipe making it like a sausage. It has then to be dried in the sun in a suitable drying place.—*The Japan Magazine.*

Light, Power and Irrigation in California

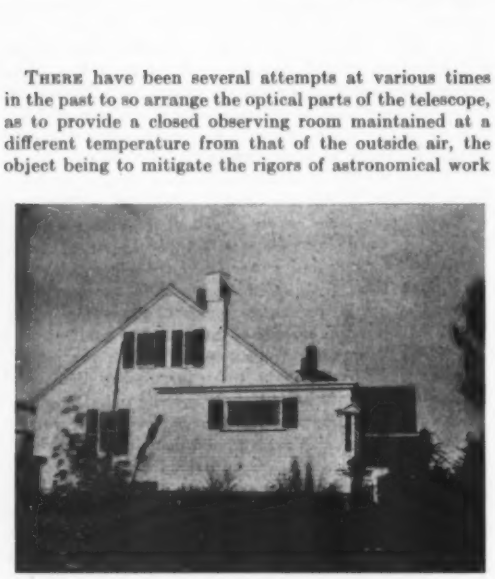
HYDRO-ELECTRIC plants have reached a high state of development in California. At present there are 110 reservoirs with a storage capacity estimated at 235,780,000,000 gallons, and the plants served produce a million horse-power in electric current which is used for light, and for power not only for running car lines but in factories as well. In many cases the current has to be carried great distances from the generating plants to the place where it is used, and as high as 150,000 volts are carried in some of the lines. One most useful feature that has been developed in planning some of the California plants is the utilization of the water, after it has done its work in producing electricity, for irrigation; and where this cannot be done directly it has in some cases been found feasible to use electric power to pump water for irrigating what would otherwise be unproductive lands.

An Amateur's Observatory*

An Attempt to Make Observation Comfortable in Cold Weather

By Russell W. Porter

THERE have been several attempts at various times in the past to so arrange the optical parts of the telescope, as to provide a closed observing room maintained at a different temperature from that of the outside air, the object being to mitigate the rigors of astronomical work



The house and observatory from the southwest.

during the winter months. Among the many efforts to demonstrate this principle may be mentioned the Equatorial Coude at Paris, the Hartness Turret telescope at Springfield, Vt., the Gerrish Polar instrument at Harvard, and the Sheepshanks telescope at Cambridge, England. These are all refractors.

The difficulties of the problem are great; the severe and long drawn out periods of observing in extreme low temperatures would long ago have been done away with, had the proper means been found for overcoming them. The writer retains a vivid recollection of the many hours at the eyepiece of a transit instrument, on a north polar expedition, and the damaging effects that such body exposures have on the quality of the work secured.

Were the efforts to bring about a closed and warmed observing room to need the sanction of professional astronomers they would be met in these words of Prof. Turner.[1]

"It is specially important to those who regard astronomy as an amusement rather than as a profession that they should not be gradually weaned from it by discomforts, as is so often the case. . . . With some device for bringing the eye end of the telescope into the comfortable study, the fascination of the work would be much more lasting. . . . The matter is worth the attention of amateurs." He cites the opinion of Prof. Pickering who wonders why amateurs have not exerted themselves further in this direction; and the case of Director Lowey at Paris, who, with advancing years, had given over the observational work of the observatory to younger men, but that, on the completion of the Equatorial Coude, he returned to the work with renewed interest.

It was more for the pleasure of working out the mechanical details of the problem than with any hopes of successfully solving it, that led the writer to the results which the present article is intended to describe.

As will be seen from Figure I, the arrangement involves the use of the Newtonian reflecting telescope, inverted, and rigidly fixed in the polar axis; and a siderostat in the same axis. All the optical parts (excepting the eyepiece) are outside and above the observing room, supported on piers that carry down to the ground without contact with the building.

With this arrangement, all light from the siderostat reaching the parabolic mirror passes along the polar axis: it is thence returned to the diagonal mirror along the same axis, where it is again deflected through the roof to an eyepiece at the focus in the room below.

As originally designed and built, the Herschellian form was tried, and the parabolic mirror was tilted enough to return the light rays direct to a focus just below the siderostat at F' (Figure I), thus saving the extra reflection of the diagonal.[2]

The transit window where the sun is observed for time, with the Hartness Sun Dial below.

Sufficient astigmatism, however, developed in the image at the focus to make this form undesirable, so an alteration to the Newtonian form was made. When this change was effected, knife edge tests of the image of a star at the focus were in every way as satisfactory as the laboratory tests when the mirrors were being figured.

The writer's first observatory, built by himself, to house a 6-inch equatorially mounted refractor. The dome is painted canvas on a light wood frame, and weighs but two hundred pounds.

The observatory was built adjoining the southwest corner of the writer's home. A part of the heavens to the northeast is obscured by the house, and the immediate vicinity of the north pole is cut off by the housing of the curved mirror; but as this is the least interesting part of the heavens the loss has not been greatly felt.

The siderostat is driven by a clock actuated by a weight. It is so fitted with setting circles, that an observer at the eyepiece can bring any desired part of the available heavens into his field of view. A photograph taken from below and looking up into the monitor surrounding the siderostat, shows the setting circles in right ascension and declination, and their control from the eyepiece.

It is now in order to cast up the advantages which this very unusual form of telescope possesses, and then to enumerate its faults. It will be well to state here that some of the defects which have developed are due to imperfect mechanical details, made necessary by the writer's inability to afford costly machine work.[3]

*Reproduced by courtesy of *Popular Astronomy*.

[1] *Modern Astronomy* (1901), p. 130-131.

[2] This accounts for the siderostat being supported by the two piers carrying the channel iron, giving the necessary open space immediately below the siderostat support. With the Newtonian form this arrangement is, of course, unnecessary.

[3] The cost of materials was roughly as follows:

For the optical parts—glass discs	$40
Abrading material	5
Silvering	5
For the building itself	100
Total	$150

As all work was done by the writer at odd times, no figures for labor are available.

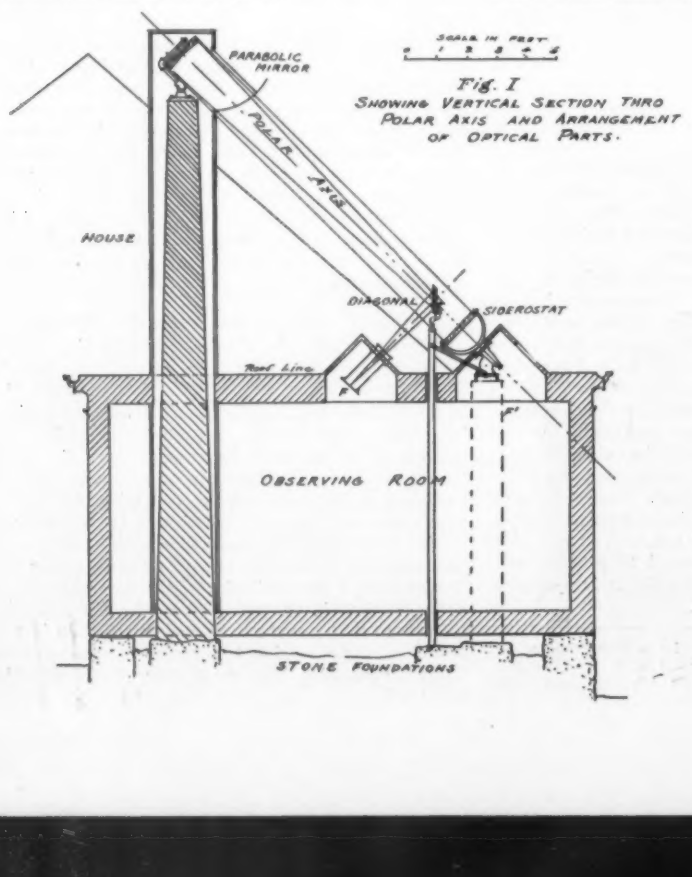


Fig. I
SHOWING VERTICAL SECTION THRO POLAR AXIS AND ARRANGEMENT OF OPTICAL PARTS.

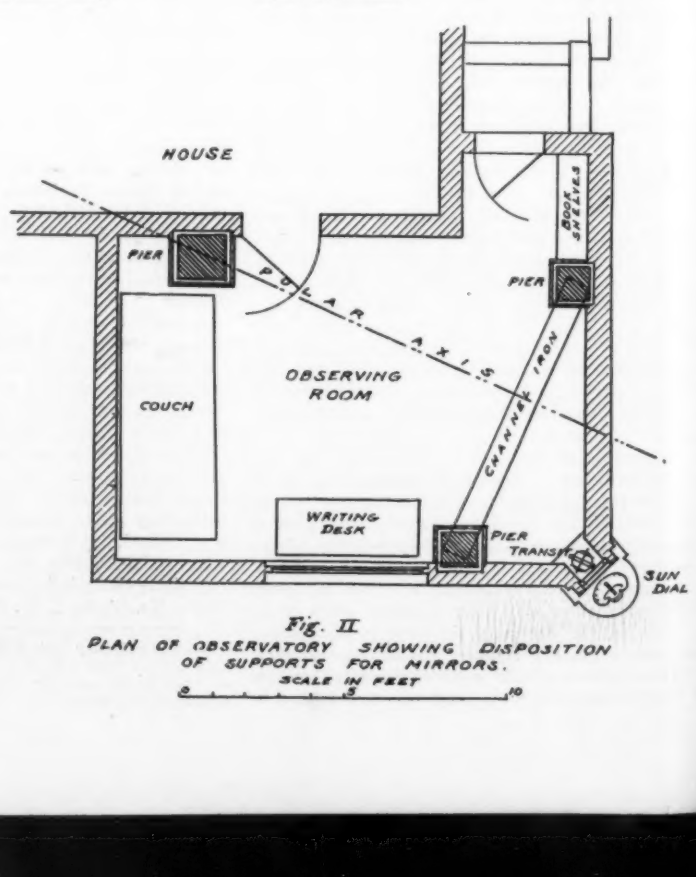


Fig. II
PLAN OF OBSERVATORY SHOWING DISPOSITION OF SUPPORTS FOR MIRRORS.

ADVANTAGES

Unquestionably the greatest gain lies in the amateur being able to work in a closed, comfortable room, which is as much a part of the home as his den or living room. It is lighted and heated like the rest of the house. With all his books and data at his elbow he will freely consult his references whenever a question arises at the eyepiece. A couch in the corner will allow him to "make a night of it" if he chooses, without disturbing the household. The host may present to his guest the wonders of our universe with the same ease as showing him a beautiful painting in the library.

The other advantage lies in the convenience of a fixed eyepiece. The observer, once he has comfortably adjusted himself in the observing chair, need not alter his position. All controls are at his hand—the quick setting on any object, starting, stopping and regulating clock. The writer has found this stationary position of especial help in drawing the details of the Moon.

DISADVANTAGES

There will always with this form of telescope be a part of the northern heavens, lying behind the box covering the parabolic mirror, that will never be seen. The area is, however, small and contains none of the bodies of the solar system.

The siderostat mounting was found to be not sufficiently heavy to prevent the image vibrating when there is a strong wind. In fact, when photographing, the air must be quite calm in order to obtain negatives of good definition. The siderostat was improvised from a six-inch Mogey equatorial mounting, by removing the declination axis which carried the telescope tube, and bolting to the polar axle a yoke in which the flat swings. As a consequence the mirror, weighing some forty pounds, considerably overhangs the support of the mounting—a construction mechanically weak. A proper mounting would probably overcome this trouble, as no further noticeable tremors could be detected originating in either the parabolic mirror or diagonal.

The siderostat mirror adds one more reflecting surface to the two already found in the common reflector, a certain amount of light thereby being absorbed and lost.

Condensation on the three mirrors have on certain nights proved very troublesome, and it is difficult to see how, in this form of instrument, it could be overcome. Hot, dry cloths, held close to the silvered surfaces will remove the moisture, but only for a time.

No dimensions have yet been given. The curved mirror is 16 inches (41 cm.) in diameter and has a focal length of 15½ (4.7 m.) feet. The siderostat is also 16 inches in diameter. Both of these mirrors are 2 inches (5 cm.) thick. The diagonal mirror is an ellipse whose diameters are 10 (25 cm.) and 7 (18 cm.) inches. It is one inch (2.5 cm.) thick. All the mirrors were ground and figured by the writer at his home on the Maine coast.[4]

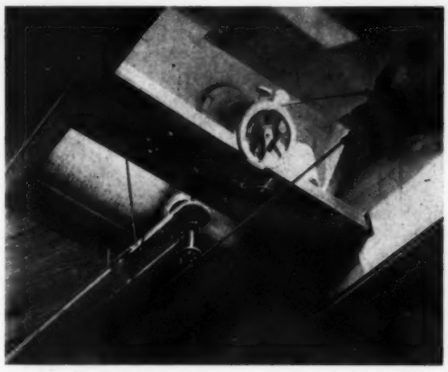
It will thus be seen that the polar reflecting telescope, as worked out by the writer, while proving the feasibility of the warmed observing room, is still subject to the evils of condensation and wind tremors: that the latter with proper mounting can probably be removed, but the former probably cannot. On the whole, its maker was very well pleased with the results. He has had but little time as yet to give it a fair trial, and has been something over a year in making it.

The photograph of the Moon accompanying this description was a first attempt to replace the eyepiece with the dry plate, and is probably not a fair sample of what the instrument can do. It was taken in this way:

The driving clock was disconnected from the siderostat and attached to the ceiling in the vicinity of the focus: the end of a cord wound around the clock drum shaft was then attached to the end of the plateholder which rested in ways parallel to the apparent motion of the Moon's image. The clock was then started and the plate exposed (2½ seconds). If it were desired to take long exposures, it would be necessary to rotate the plateholder.

In closing this account the writer feels quite ready to recommend this instrument, not to professionals, but to those persons who, appreciating the wonders of the heavens, have hitherto foregone the pleasures of astronomical work from a disinclination to submit themselves to its inconveniences. The writer's experience has been this: four years ago he acquired a six-inch refractor and mounted it beneath the dome of the standard type. As a consequence, months at a stretch would pass, especially during the colder weather, without the observatory being used. It being only a hobby, he simply would not go to the trouble of bundling up, and the discomfort of standing still and shivering through the cold nights. He thus missed some of the best nights of the year for seeing. When the new observatory was completed, the exact reverse obtained. Scarcely a clear night passed that he was not at work in the room.

[4]For the benefit of those who desire to make their own reflectors, they are referred to M. Thos. Fullan, Director of Instrumental Section, Society of Practical Astronomy, Auburn, Ala., who, I am sure, will be glad to furnish simple directions for prosecuting this fascinating work.



Looking up at the ceiling of the observing room, showing the siderostat mounting, and controls from the eyepiece just outside the lower left hand corner of the photograph.

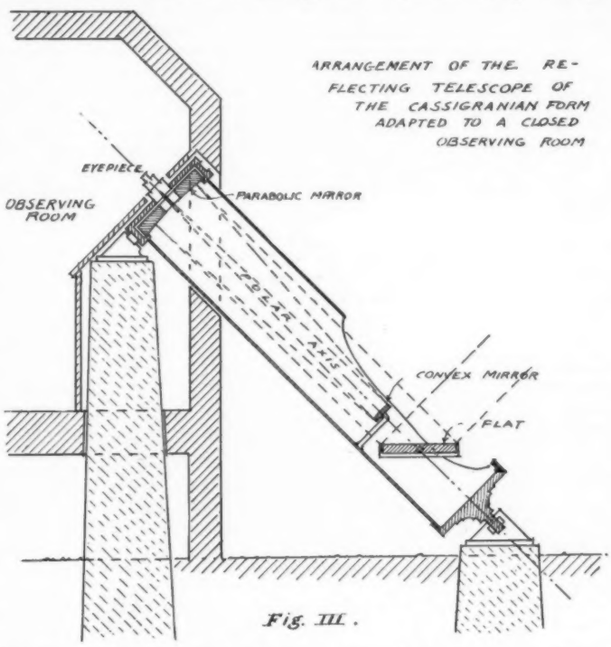


Fig. III.

There is another form of reflecting telescope which it would be interesting to apply to this idea of a closed observing room—that is the Cassigranian. The arrangement is suggested in Figure III. As will be seen, all three mirrors are enclosed in the telescope tube which revolves in the polar axis. The eyepiece is just behind the parabolic mirror, in the room, at a convenient height above the floor. The flat mirror is at the opposite end of the tube in bearings at right angles to the polar axis, and a part of the tube removed to permit the maximum range in declination. The driving mechanism would be applied to the upper end of the tube, at which both controls—right ascension and declination—would be located.

Advantages of this arrangement would be—the bringing of all supports much nearer to the ground; the assembling of all optical parts in a compact unit; the convenient position of the observer when sitting at the eyepiece; and the probable reduction of troubles arising from wind tremors and condensation. Against these points in its favor must be mentioned the limited range in declination—from the southern horizon to about thirty degrees north of the zenith.

One or two other features of the observatory may be of interest. In Figure II may be seen a small corner bay window. Here is located a 4-inch alt-azimuth instrument. A south meridian mark, situated some two miles out in the Atlantic Ocean on the Old Scilly Ledge, serves to bring the instrument into the meridian for the purpose of obtaining correct time. Just outside of the transit window is seen the Hartness sun dial, from which, after adjustment, the mean time may be read off directly. Inside the observatory the walls are covered with maps and charts of the north polar regions where the writer has spent many years in astronomical and topographical work—Franz Josef Land, Greenland, Labrador, and Alaska.

The observatory is located on a point of land jutting out into the Atlantic at the small fishing town of Port Clyde, lying about one hundred and fifty miles north-east from Boston on the Maine coast.

Photograph of the Moon made by the author

Melting Furnaces at the British Mint

ALL the furnaces at the Royal Mint are designed to burn gas at 3-inch pressure with air at 2½-pound pressure. The rate of gas consumption by sixteen large furnaces is about 15,000 cubic feet per hour. A 6-inch service pipe is used for delivery, and this provision is well in excess of the requirements, an ample reserve being considered essential in order to obtain uniformity in results. Air for the burning mixture is supplied by three rotary blowers, each blower being capable of delivering 36,000 cubic feet of free air per hour. The blowers are all motor-driven, the maximum horse-power required being forty-five. The gas and air pass through a mixer, the respective volumes admitted being governed by valves, the levers of which move over a graduated quadrant, and require adjustment as the temperature rises in the furnace. The method of connecting the mixing chamber with the ignition inlet is regarded as being of the first importance in securing efficiency. A right-angled elbow-pipe, having a screwed endpiece with a diminishing bore, forms the nozzle, and leads to the ignition hole of the furnace, which consists of a perforated firebrick of special shape. A recess at the back of the block receives the iron nozzle, which fits the recess closely and is surrounded by asbestos packing. The large block of firebrick serves to keep the nozzle relatively cool, and is built into the brickwork in a position to induce the flame to pass between the crucible and the wall of the furnace. The gas flame on leaving the ignition hole travels round the crucible in an upward double spiral. The crucible is placed centrally in the furnace upon a graphite stand. Only sufficient clear space is allowed round the crucible to admit of lowering the furnace tongs preparatory to drawing the pot. The products of combustion from each furnace are conducted through the apertures to the main flue, which runs underground and parallel to the line of furnaces to the chimney-shaft. This flue also passes through a condensing chamber provided with baffles to intercept any solid matter carried off from the furnaces by the draught.

During five years (1911-16) coinage metals to an amount of 9,900 tons were melted.—From the *London Daily Telegraph*.

Mechanical Power of the United States

THE total mechanical power in the United States is estimated, says *Power*, at 120,000,000 horse-power. This includes 19,400,000 horse-power in manufacturing industries, 7,700,000 in central light and power stations, about 7,000,000 in isolated plants, exclusive of manufacturing, 3,400,000 in electric railways, 50,000,000 in steam locomotives, 4,000,000 in steamships, 22,500,000 in automobiles, and the balance in miscellaneous services.

The Electrical Properties of Gases—IV.*

Which Enable Important Problems in Physics To Be Studied

By Sir J. J. Thomson, O.M., P.R.S.

CONTINUED FROM SCIENTIFIC AMERICAN SUPPLEMENT No. 2169, PAGE 55, JULY 28, 1917

IN opening the fifth lecture of his course on the above subject, at the Royal Institution, Sir J. J. Thomson, O.M., P.R.S., recalled that on the last occasion he had discussed the relationship between the potential required to produce a spark and the width of the gap and the pressure of the intervening gas. He had pointed out that this potential depended solely on the quantity of gas present between the electrodes, so that so long as the product of the gaseous pressure and the width of the gap was constant the potential needed to produce a spark was also constant. It was a matter of indifference whether the length of the spark gap was small and the pressure great or the distance large and the pressure small. Hence, while in general the potential needed increased with the length of the spark, there was nevertheless a limit beyond which it was (with the gas at constant pressure) more difficult to get a short spark than a long one, and with very short gaps it became almost impossible to get a discharge at all. He proposed, on the present occasion, to explain some principles on which this peculiarity of the spark discharge might have been foreseen.

Consider, he continued, what was the condition essential for electricity to pass through a gas. This, as he had pointed out in a previous lecture, was a supply of negative and positive particles derived from the gas itself. By the action of rays of various kinds such particles could be liberated in a gas, but in the case now under consideration the gas, in order to conduct electricity, must manage to produce these ions for itself without the aid of some external agent. This the gas was able to do with the help of such a residue of negative particles as might naturally exist in the gas. Thus any such negative particle in the gas would, under the influence of the electric field, acquire velocity and energy. It would, moreover, sooner or later collide with a molecule of the gas, and if the energy it had acquired exceeded a certain limit the shock of the collision would split up the molecule into positive and negative ions. Being still under the influence of the field the original negative particle would again acquire velocity and energy sufficient to split up another molecule of the gas, and at the same time the negative particle it had liberated from the first molecule it encountered would act like its parent, and also acquire sufficient energy from the field to split up any molecule it met. The original negative particle in this way continually "bred" new negative particles on its course through the gas. In some cases it did this at a uniform rate, and each negative particle liberated at each encounter would act similarly, so that the number of these particles increased according to the compound interest law. Hence if A_0 denoted the number of particles originally present and a unity plus "the rate of interest," the number present after the lapse of the time t was given by the formula $A = A_0 e^{at}$. The rate at which these negative particles increased was, therefore, very great.

Something more than this was, however, needed to maintain the conductivity of the gas and to make the discharge self-sustaining. Under the influence of the field all the negative particles would be gradually swept away from the cathode, leaving nothing there to make the gas conductive by fresh ionization. Hence other means of ionization were necessary. This agent need not, however, be a powerful one in comparison with the negative particle. Thus suppose that each negative particle produced a new negative particle for each millimeter of its travel along the field. In a traverse of 3 mm. each would, by the formula already given, have raised its progeny to e^3, or, in round numbers, to 20. In 6 mm. the number would be $20 \times 20 = 400$, and in 15 mm. the number would be over 3,000,000. Each of these 3,000,000 negative particles would be accompanied by its corresponding positive ion. But to keep the system going it was only necessary to replace the single original negative particle, or, in other words, the 3,000,000 positive particles were only called upon to ionize one molecule of the gas. The discharge would, accordingly, be self-sustained even if the chance of ionization being affected at a single encounter between a molecule and a positive particle was almost infinitesimal.

Small as was the demand made, however, it had to be satisfied, but it need not necessarily be met by ionising action on the part of the positive particles. He was, Sir Joseph Thomson continued, by no means sure that the part played by these positive ions had not been overrated, and that the maintenance of the discharge might not quite possibly be due to radiation resulting from the impacts of the negative particles producing a sort of Röntgen radiation, part of which would strike back to the neighborhood of the cathode. He thought the effect of this radiation had been somewhat overlooked in considering the mechanism of the discharge. Whatever the mechanism in action, it need only be feeble, since millions of agents were available. Hence from the practical standpoint the discharge might be considered as due to the fact that the negative particles were able to ionize the gas. Theoretically the positive ions came in, but so many of these were produced that they must be extraordinarily incapable if between them they were not able to produce the single negative particle required. If a traverse of 15 mm. gave 3,000,000 positive particles, one of 30 mm. would yield the square of this number, or 9×10^{12}. Hence, whenever there was so much gas between the electrodes that collisions were frequent, the criterion for a continuous discharge was that the negative particles should be able to ionize this gas. The condition might be expressed in the following fashion. Let X denote the electric force and λ the average distance between successive collisions of a negative particle with a molecule. At each collision it might be taken that the whole of the previous history of the negative particle was wiped out, and it had to start anew acquiring energy. Hence the distance λ between successive collisions must be such that the force X had time to give the particle the energy Q required to ionize the molecule. Hence

$$X = \frac{Q}{\lambda}$$

If V denoted the potential difference between the electrodes and d the distance between them, we had $V = Xd$.

Moreover, λ, the distance between successive encounters, was inversely proportional to the pressure of the gas, so that

$$V = \frac{Qd}{\lambda}$$

or $V \propto Qdp$

and was therefore constant when $p\ d$ was constant.

He had shown how easy it was to get up into millions of ionizing collisions. Conversely, by halving the pressure or the distance between the electrodes, the number of ions produced might be reduced from a million to a thousand. On again halving the pressure or the distance, the number would fall to a little over thirty. Halving again would reduce the number to less than six. In that case the task set the positive particles of producing the single negative ion was very different from what it was when there were millions of them available for the job. To get a discharge in such conditions it might be necessary to increase X, the electric force, to quite abnormal values before a self-sustaining discharge could be realized.

By still further reductions of the pressure the collisions with the molecules might be so few that but one negative particle out of a thousand would ionize a molecule and produce a positive particle. To maintain the flow in such case, this single positive particle would have to produce 1,000 negative ones in order to keep up the supply. Hence a stage must be reached when the discharge would fail—too few positive particles being produced to maintain the necessary supply of negative ones. It was easy to see, therefore, that at very high vacua a high potential difference would be required.

Similarly, if the pressure were high, the path λ between successive collisions became very short, and a high potential difference would again be necessary to produce a discharge. It followed, therefore, that the graph representing the voltage necessary to maintain a spark at different pressures would have the general

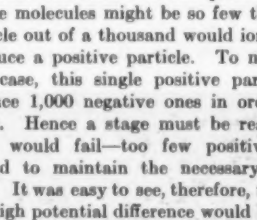


Fig. 1.

form indicated in Fig. 1, and that at some point this potential would have a minimum value. In the case of air this minimum value was, roughly, 300 volts, and the product Pd corresponding to this minimum potential was approximately 7, when P was measured in millimeters of mercury and the distance d was expressed in millimeters. At this minimum potential the distance between the electrodes was about fifteen times the mean free path of the molecules, so that when the discharge was passing very freely a negative particle would have about fifteen collisions in passing from one electrode to the other. These collisions might be associated with the production of a sort of Röntgen radiation instrumental in producing the additional ionization, which was necessary to maintain a steady discharge.

Ordinary cathode rays, the lecturer continued, caused glass to phosphoresce, and so did the radiation to which he referred. This new radiation, however, caused glass to phosphoresce a dark olive-green color, quite distinct from the yellowish-green phosphorescence produced by the cathode rays. The new radiation could, moreover, be refracted through white fluorite, and was no doubt a form of light well up in the Schumann region of the spectrum. It had very great powers of ionization, and the speaker thought it quite possible that the additional ionization required to maintain the discharge was produced by this soft type of Röntgen radiation.

It might be noted that luminous radiation might also be produced by the impact of negative particles with the molecules of the gas in a discharge tube. This the speaker demonstrated with a tube in which the cathode was a hot filament of wire supporting a speck of lime, which, in these conditions, emitted a large quantity of negative particles. These acquired velocity in passing through the electric field which was established between the two electrodes of the tube, and the energy given them could be varied by altering the potential difference

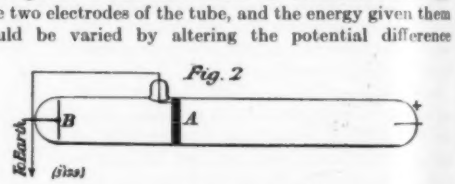


Fig. 2

between these two electrodes. The lecturer showed that with 40 volts' difference of potential the gas in the tube was not rendered luminous by its collisions with the cathode particles, but that with 80 volts the luminosity was quite distinct. The change, he said, took place quite abruptly on the attainment of a certain definite voltage, which was that at which the moving particles acquired sufficient energy to ionize the gas.

The visible radiation thus produced had, however, itself no power to ionize the gas, but with higher voltages the soft Röntgen radiation referred to above was also emitted, and this was able to produce ions, an effect which had not hitherto been taken into account.

The ordinary kind of discharge could be explained if the field were of uniform strength from electrode to electrode, and the graph representing the electric force at each point was then a straight line parallel to the base. There were, however, cases in which the electric force was not uniform throughout the tube, and in that case the appearance of the discharge was also not uniform. This effect was observed over a certain range of pressures only, and with certain gases. At fairly high pressures the luminosity of the positive column was uniform from end to end. If, however, the pressure were continuously lowered a stage was ultimately reached when the column broke up into a series of detached portions of luminosity, separated from each other by dark spaces. If, however, the pressure were still further lowered these striations disappeared and the luminosity became uniform again.

This the lecturer demonstrated with a discharge tube in which the pressure was varied by absorbing the residual gases with charcoal cooled in liquid air. The effect was, the lecturer showed, also dependent on the diameter of the tube, so that with a tube consisting of a wide and narrow portion in series with each other the striae were much closer together and more difficult to produce in the narrow portion than in the wide.

The lecturer next showed what was, he stated, a somewhat paradoxical experiment, in which the complete phenomena of the discharge in a vacuum tube were obtained with no difference of potential between the electrodes. The apparatus used is represented in Fig. 2. It consisted of a long tube with a positive electrode at one end as indicated; while there was a cathode at A with a hole in it and a third electrode at B. The two

*From a report in *Engineering*.

terminals A and B were connected together by a wire, which was earthed. Hence both A and B were at the same potential. On establishing a discharge between A and the positive electrode, however, the whole of the phenomena of the discharge were repeated in the left-hand extension of the tube between A and B. There were the negative glows, the dark spaces and the positive column, which showed striations. This result was obtained although A and B were at the same potential. The effect originated, the lecturer said, in the passage of positive particles through the hole in A, and he showed that it disappeared entirely if the direction of the current was reversed. The electric force averaged over the space between A and B was zero. At some points in the interval it was opposed to the current, while at others it favored it.

This experiment served to emphasize a most important point. In dealing with a discharge at low pressures we had not to deal so much with the value of the force at a particular point as with its average value over a considerable distance comparable with the mean free path of the particles. In order to produce ionization the particles must have acquired a certain velocity, and if the path were very short, so that the force might be taken as uniform over its length, we had the relation; energy acquired = force × distance. If, however, the path were some centimeters long and the force variable from point to point, it was necessary to average it over the whole path, so that we had to deal not with its value at particular points, but with its integral over a considerable distance. Hence the requisite energy might be acquired even if over part of the path traversed the force acting on the particle was negative.

Professor Thomson stated that he had himself measured the distribution of the force in the neighborhood of the striations. The convex side of a striation was turned towards the cathode of the tube, and he had found that just in front of the convex side of the luminous patch the force was negative; that is to say, it was tending to move the particles in the wrong direction. It then increased very rapidly as the striation was more closely approached, and rose to a considerable positive value. It then fell off again quite slowly to a negative value, and the cycle was repeated at the succeeding striation. All up the steep portion of the curve of electric force there was, the lecturer stated, a great preponderance of negative particles, while on the reverse slope of the curve of force the positive particles preponderated.

To map out the state of the electric force in the neighborhood of the striations he had employed a fine stream of cathode particles shot across the discharge tube and falling upon a glass screen, where they produced a spot of phosphorescence. He had used for discharge tube the vacuum over the mercury in a very long barometer tube. The two electrodes were connected together by a sheet of glass, and the whole unit, thus formed, was floated on the mercury. By altering the level of the latter a striation could be moved up past the fine cross-stream of cathode particles, and the state of the field traversed by these was shown by the displacement of the phosphorescent spot on the glass. In cases in which the pressure in the discharge tube was too high to permit of cathode rays being produced, he had taken advantage of the fact that to produce a very short spark a big E.M.F. was required. He had, therefore, enclosed the cathode in a capillary tube, so that there was not room for the production of an ordinary spark, and cathode rays were obtained instead.

In this way he had found that the force might be actually negative on the cathode side of a striation, provided the pressure was quite low. At higher pressures it did not become actually negative, but fell much below its average value.

How were stable striae possible? Suppose we started with a particle moving slowly in a region where the force was very low. Its energy would then for a certain distance be too small to produce ionization, and the tube would therefore show a dark patch. As the particle proceeded, however, it ultimately acquired a velocity sufficient to ionize the gas, producing thereby positive particles which moved so slowly that they might, as a first approximation, be regarded as at rest.

These positive particles remaining nearly stationary, while the negative ones moved on, counterbalanced somewhat the negative charge, but the field went on increasing until a point of the tube was reached where the number of positive particles present was equal to the negative particles there present. At this point the graph of the electric force became horizontal and then fell, since a negative particle having passed through this point would be attracted back by the positive charges left behind it. The rate of ionization did not, however, begin to fall off at the same time as the field, since the position in which the electric force attained its maximum value was not the same as that in which its integral over a certain distance became a maximum, so that the energy of the negative particles still continued to increase for some time. Ultimately, however, it fell below the ionization point, and the particle had then to pass through a portion of the tube in which there was again nothing but negative ions; but as it was approaching a region where the positive particles were again in excess, it acquired velocity afresh and the cycle was again repeated. The alternations of brightness characteristic of striation were in this way produced. To obtain them it was necessary that the drop of potential from center to center of two striae should be less than would be required if the force were uniform over the whole distance.[1]

In conclusion the lecturer stated that the condition in which the total fall of potential required for the transport of the ions between two points was less with a non-uniform force than with a uniform one, held only between certain limits of pressure.

[To Be Continued]

[1] [As a mechanical analogy we would suggest the case of a gravity railway. It is known that the path of quickest descent between two points at different levels is not a straight line but a cycloid, and if passengers were to be transported between two such points the capacity of the line, or the number of passengers carried over it in a given time, would be greater if the line were laid out to the path of quickest descent than as a uniform gradient.—Editor *Engineering*.]

Removal of Stains in the Laundry*

As a rule, the washing process, as carried out in the laundry, easily removes most of the stains from the goods. Hence, it is only in exceptional cases that a laundry worker must resort to special chemicals to remove them. It is, however, good policy to be prepared to use regular spotting agents for the removal of any obstinate stains, for a little attention paid to the removal of such stains will pay well. I have frequently sent to the laundry collars which were spotted with ink or color, and generally I have had them returned minus the dirt but still stained. It is such a simple matter to remove stains of this character, and the number received is so small, that it is a shame not to make an effort to eradicate them.

In order to simplify the classification of stains, I have divided them into two groups, which I have called "oil or fat stains" and "color stains." Stains of the first group are caused by lubricating oils, food greases, tar, paint, varnish, etc., and are characterized by perfect insolubility in water. In order to treat stains of this description satisfactorily, it is necessary to make use of chemicals in which they are soluble. The so-called organic solvents do the work perfectly. Color stains are due to highly colored fruit juices, inks and dyes. These stains are frequently met with and are very noticeable. In order to eradicate these stains it is necessary to destroy the color, for which purpose the so-called "bleach spotters" are used.

There have been stain removers on the market for which the claim is made that they will remove any spot from any fabric. That one chemical or mixture of chemicals can eradicate successfully all stains is out of the question, and even if such a product were possible, it would be more expensive than taking the proper chemical for each case. The following six solutions will take care of all the stains which are met with in the laundry. It is possible to get down to only six solutions by considering the fact that the washing process in itself removes a great many stains.

ORGANIC SOLVENTS

Aniline oil, commercial strength.
Ether, commercial strength.
Carbon tetrachloride, commercial strength.

BLEACH OR DISCHARGE AGENTS

Hydrosulphite, conc., powder form.
Hypochlorite of soda, 2 degrees Tw.
Oxalic acid, 5 per cent solution.

*A. F. Musgrave in the *National Laundry Journal*.

The following matter relates to the removal of the various stains from white goods. There is always danger in the use of a spotter on colored goods, and this is especially true of the bleach or discharge spotters.

Oil, Grease, Tar and Paint Stains.—Stains due to lubricating oils are generally unaffected by the washing process, but they may be removed with carbon tetrachloride. Carbon tetrachloride also has the advantage that it is not inflammable. Grease stains, if due to animal fats, such as gravies, etc., are removed in the washing, animal fats in general being very easily saponfied. Tar is very difficult to remove, but the best thing to do is to rub the spot well with lard, in order to soften it, and then treat it with warm carbon tetrachloride. Paint, varnish and linseed oil stains are rapidly removed with hot aniline oil. Aniline oil will in itself leave a spot, but it may be removed with ether. Aniline oil should be kept protected from the light or it will become very brown in color, due to oxidation.

Color Stains.—Ink stains may be removed with the oxalic acid solution, followed by hypochlorite if the stain still remains. The treatment with oxalic acid is to remove the iron which is contained in most inks, while the hypochlorite rapidly bleaches any coal tar color which may be present. Stains of dyestuff are treated with hypochlorite, which removes all except a few yellows and browns. This treatmeht, however, is only of interest for cotton goods, woolens being turned yellow by this reagent. In point of efficiency, hydrosulphite ranks next in the removal of color stains, and is especially valuable for colored cotton and woolen goods. While hypochlorite of soda removes color stains very rapidly, it acts too efficiently to be of value for removing stains from light colored goods. As before stated, as it is not of value for wool and silk, its application is rather limited. Hydrosulphite of soda may be used on all fibers except tin-weighted silks, which it turns gray. Hydrosulphite of soda is also better suited to the removal of fruit stains, particularly those yellowish stains which appear to be fast to chlorine.

The hydrosulphite compound which is of special value for the removal of stains is the sodium compound, which readily dissolves in water without the aid of acids. One or two ounces of this product added to a load of badly-stained or gray-looking goods will whiten them considerably. To use it as a spotting agent, a little should be dissolved in warm water, immediately before use, and the solution applied to the stain in the usual manner. It is also possible to moisten the stain and apply the dry product, but this method is much harder to control. As this product loses its strength rapidly in solution, only enough should be dissolved for the job in hand.

Barometric Gradient for Discovering Unknown Seismic Zones

VARIOUS Japanese investigators have found that the barometric gradient offers a means of discovering unknown seismic zones or faults, as it was shown that the prevailing gradient at the zone at the time of an earthquake was nearly perpendicular to the seismic zone. The method was found more feasible and more accurate than that of constructing zones statistically by locating a large number of epicenters.—From a paper by A. H. PALMER on California Earthquakes during 1916, in *The Bulletin of the Seismological Soc. of Am.*

Determination of Carbon in Steel by Micrographical Examination

THE estimation of carbon in steel by measuring under the miscroscope the relative proportions of ferrite and pearlite, may be disturbed by the inequality of the distribution of carbon throughout the metal. This heterogeneity, which is not indicated by chemical analysis, may be detected by observing large surfaces with a low magnification. Errors may also arise through the ferrite and pearlite being deposited in laminated schistlike form. In this case, duplicate sections, one parallel, and the other perpendicular, to the direction of the alinement of the layers, should be examined. Variations in the fineness of the texture lead to the necessity of varying the magnification with each specimen, so as to bring the mean dimensions of the areas of ferrite and pearlite to the same scale. Samples of metal for examination must first be subjected to the same conditions of annealing, as the structure of the pearlite and its association with ferrite and cementite are largely modified by the heat treatment received. The presence of manganese and chromium, which affect the relative proportions of ferrite and pearlite, gives an illusory high value in the micrographical estimation of carbon.—Note in *Journal Society Chemical Industry* in an article by A. PORTEVIN, in *Rev. Mét.*

New Carbon Remover

MANY preparations have been put on the market for quickly removing carbon from the cylinders of gasoline engines. The latest to appear is acetol, a liquid applied by injection through the spark plug opening. It is asserted that the carbon is thus rapidly softened, and the detached material is blown out through the exhaust when the engine is restarted.

Setting up the gun for operation on the ground

Photo by Press Illustrating Service, Inc.

A machine gun as mounted on a sidecar

Motorcycle Machine-Gun Batteries

Their Important Work in the War

ALTHOUGH we are preparing for a war in which everything is new, in methods, materials and tactics, and when everything must be done at once, and often with inadequate information as to actual requirements, it would seem that too little attention has been given to the question of motorcycle machine-gun equipment; and yet this is a most important branch of service on the battle fronts of Europe. Of course machine guns are employed in large numbers in the trenches in semi-permanent positions, but one of their most important functions is to meet emergencies. The enemy makes a sudden drive at an unexpected point where there are but few men to hold the line. The only way to meet the emergency is to get machine guns to the danger point to enable it to be held until reinforcements can be rushed up, and the only way to do this with sufficient promptness is to employ motorcycles with suitable side-car attachments fitted to carry the guns. Then again, it is desired to bring a sudden enfilade fire on an enemy trench, or to dislodge an observation or sniping post, and this would in many cases be impossible for foot soldiers with individual rifles, but can be successfully accomplished by the use of the motorcycle. These are only a few out of a multitude of ways in which these batteries have been found indispensable.

England alone has in the neighborhood of 30,000 machine guns mounted on motorcycles, and has found them indispensible for just such work as is suggested above, and for many similar occasions; and all of the other allied nations are undoubtedly equally well supplied. Without machine guns no infantry can be considered to be adequately supported, and to make them effective they must be made as mobile as possible. In this work the automobile has not been found as efficient as the motorcycle, as the lighter and more flexible machine can be quickly brought to positions that are not accessible to the large cars, and the latter also have the disadvantage that they are more easily seen by the enemy, and consequently offer better targets for both rifle and gun fire.

Contrary to the impression we are apt to get from many sensational pictures that have been published, the machine guns are seldom operated from their motor carriages for the reason that these carriages do not afford a sufficiently rigid firing platform, and, moreover, when so operated, they offer altogether too conspicuous a target.

It is therefore customary to leave the motorcycle at a safe distance in the rear and to carry the gun forward to the desired location, where it is set up on a special tripod on the ground. Occasions have occurred where a machine gun battery has unexpectedly run into a picket or scouting party of the enemy, when of course the machine-gun men have done the best they could by firing from the motor mount, but these are exceptional cases, and not counted on as regular maneuvers.

In all of the earlier motorcycle machine-gun batteries the guns have been mounted on tripods set on the side-car platforms, but as a result of experience the opinion is now gaining ground that it is better to do away with this car tripod, and to strap the gun on the machine in the lowest position possible, as it has been found that by thus lowering the center of gravity of the outfit it can be operated with greater speed over rough ground, and more effectively than when the gun is carried in the old way. If an emergency such as above mentioned arises, the men would have to depend on their automatic pistols for fighting, and these are considered to be as fully effective under the conditions as the gun would be. These men never carry rifles.

In organizing a motorcycle machine-gun battery, the men should not only be good riders and operators, but they should be so intimately acquainted with the mechanism of their machines that they can keep them constantly in good working order, and be able to make all ordinary repairs, for although, in the armies of Europe, efficient repair stations are maintained at suitable points in the rear, it is not always convenient or possible to take a defective machine to the rear, and an

Utilizing a field of daisies as a screen for the machine-gun

ingenious rider, with a familiarity with the use of ordinary tools, can do wonders in keeping his machine going under adverse circumstances, a consideration of utmost importance.

While there is sensation enough in the everyday work of the machine-gun battery, and the machines have to be rushed at great speed over rough country, reckless driving is consistently discouraged as it results in unnecessary destruction of the machines, and every effort is made to save the machines and keep the battery at all times in a condition for instant service.

While the heavy twin-cylinder machines so popular in this country are not considered in Europe to be particularly well adapted for dispatch work, they are eminently fitted for the work of transporting machine guns, and for this are probably better than any other motorcycles produced in the world, as the rough roads in this country have tended to develop types and methods of construction that result in unusual strength and reliability, and consequently they are particularly suited to the heavy work of transporting machine guns over rough and difficult country.

The accompanying illustrations are not war pictures, but show a machine-gun battery of the New Jersey militia doing training work; and it may be said that in a number of States batteries of this kind have been organized during the last two years that may be relied on to give a good account of themselves in the near future. These little units, however, are far too few, and to properly support our troops that are being sent abroad thousands more are needed at once.

The Zeiss-Abbe Refractometer

A COMMUNICATION has reached us from Messrs. Bellingham and Stanley, Ltd., in which attention is directed to an interesting point in connection with the design of the Zeiss Abbe refractometer. It has been observed recently by users of the instrument that, owing to want of illumination, measurements cannot be made for liquids having a refractive index greater than 1.52. It is plainly stated in the Zeiss catalogue that the Abbe refractometer may be used for the measurement of refractive indices from 1.30 to 1.7, and that the liquid to be examined is enclosed between two prisms of flint glass. In the instrument as actually constructed it appears that a crown glass prism of low refractive index ($N_D = 1.52$) has been substituted for the dense flint prism ($N_D = 1.75$) used at first as the lower or illuminating prism. The contact surface of this prism is left unpolished, so as to scatter the light entering the liquid film. The process of wiping the surface to remove the liquid which has been examined results in the removal of the thin sharp walls left by the abrasive, and the surface approximates to a polished face. When this is the case very little light can fall on the contact surface of the liquid and the upper prism at angles greater than the critical angle unless the lower prism has a refractive index greater than that of the liquid under test; for it is only when this condition is satisfied that light entering the liquid is bent away from the normal. Several such instruments have been rendered serviceable for the measurement of liquids of refractive index as high as 1.70 by replacing the crown illuminating prism by a suitable dense flint prism—*Nature*.

Method for the Detection of Phosphorus

CRITICAL examination of this method (formation of hydrogen phosphide by treatment with zinc and hydrochloric acid) showed that it could be employed for the detection of very small quantities (0.0025 mgrm.) of phosphorus in the form of phosphites or hypophosphites, provided that the gas first evolved was passed into silver nitrate solution, the precipitate of silver phosphide collected, again treated with zinc and hydrochloric acid, and the coloration of the hydrogen flame then observed. In dealing with phosphites, etc., the reduction proceeded most satisfactorily at about 55° C. The silver phosphide was not appreciably oxidized by contact with the excess of silver nitrate. There appeared to be no advantage in the spectroscopic examination of the hydrogen flame. In cases of poisoning by phosphorus, the method appears to be of use; the phosphorus is found chiefly in the stomach, remaining unoxidized for some few months, and phosphorus compounds do not appear to be formed during decomposition of the body. Pure zinc for use in the method may be obtained by fusing the metal with a small quantity of metallic sodium, followed by granulation.—H. J. LEMKES in *J. Pharm. Chim.*

Workers In Compressed Air*

Precautions Adopted by the N. Y. Public Service Commisson for Protecting Their Health

By Edward Levy, M.D., Physician to the Commission

THE use of compressed air in subaqueous work has been common practice during the past 75 years, but, until recently, very little progress has been made in the elimination of compressed air illness among the workmen. This has been a serious deterrent to carrying on work of this character. The present day treatment of compressed air illness probably dates from the time when E. W. Moir, in 1890, introduced the medical lock for decompression, in connection with the construction of the first tunnels under the North River, which, after many mishaps, were completed in 1908.

The sinking of caissons for bridges and building foundations had always been attended with numerous cases of compressed air sickness, oftentimes fatal. The large tunneling projects in the United States and England offered the first general opportunities for the study of large numbers of men employed in this class of work. The period from 1902 to 1908 was marked with great activity in compressed air tunneling in New York City, by the construction of six tunnels under the North River and eight tunnels under the East River.

SOME IMPROVEMENT

While each succeeding large enterprise showed some slight improvement, the results were so far from being satisfactory that it was found necessary by the Department of Labor of the State of New York to formulate certain rules for the protection of the men employed in compressed air.

Probably the best record previous to 1914 was that made during the construction of the Pennsylvania tunnels under the East and North Rivers. The record on the Pennsylvania work was regarded as exceptional, there having been but 3,692 cases of "bends" reported, with only 20 deaths. The latter figure was thought an extremely small number of fatalities for this character of work. The results obtained were due to the great care exercised by those in charge who provided a staff of physicians assisted by nurses trained in the particular work of handling compressed air illness. While it was found that the results of the Pennsylvania work were much better than had previously been obtained, yet they were not considered satisfactory.

Realizing the unprecedented magnitude of the compressed air tunnel work which was about to be undertaken under the Dual System contracts, the Commission determined at the outset to obtain the best possible working conditions for the men employed in the tunnel headings. To this end, conferences were held with medical experts and the experience of the engineers themselves was utilized. It was recognized by those charged with the carrying out of this work that, in order to prevent as far as possible compressed air illness among the engineers and workmen, there must be enforced the most rigid requirements for the conduct of the work, particularly as to the selection of the men employed, the hours of labor, the methods of decompression and the facilities for the treatment of the men in case of compressed air sickness.

SPECIFICATIONS PREPARED

To this end, specifications were drawn up in accordance with the labor laws, with additional requirements to fit this particular work. It was provided in the specifications that the quarters for the workmen should be fully equipped with proper facilities for bathing, resting, drying the clothing, and for a supply of hot coffee at all times; that the hospital room have an attendant constantly in charge; that a medical lock with two compartments be furnished where the men could be subjected to treatment if attacked by compressed air illness; that this lock should contain cots, a telephone, an air gage; that there should be arrangements for the removal and hospital treatment of any employe who required it; that every person employed in compressed air should be subjected to a rigid medical examination, and employed only if found to be fit to engage in such work; that such employe should be subjected to re-examinations during the course of the work, in order to watch his physical condition, and that all parts of the tunnel should be kept in a thoroughly sanitary condition and free from refuse.

That the conditions attending decompression should be as nearly ideal as practicable, it was required that whenever the air pressure exceeded 22 pounds per square inch there should be an intermediate chamber, so that the men would be required to pass through two air locks; that each lock be provided with an air gage and a clock, so that a record could be kept of the decompression, and a lock tender must be on duty at all times to decompress the men as directed.

In addition, the question of air supply in the tunnel headings was specifically covered in that the contractor was required to cool the air, so that the temperature should be moderate at all times; that the supply of fresh air should be sufficient to prevent the accumulation of carbon dioxide to a greater amount than one part in a thousand; and that adequate ventilation should be provided by means of vent pipes carried from each heading under pressure to the outside atmosphere.

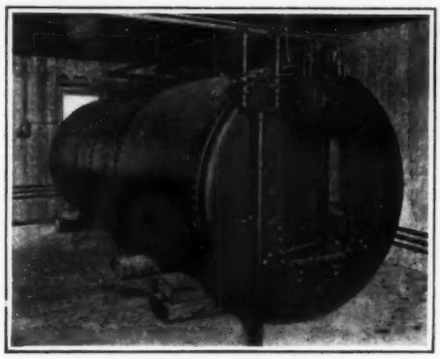


Fig. 1—Medical lock

SYMPTOMS OF DISEASE

There are several symptoms of compressed air sickness; one, the so-called "bends," another termed "chokes," and still another known as "staggers." In some cases paralysis, and in extremely severe cases collapse and death occur. The symptoms are due to the liberation of bubbles of nitrogen, which, taken up in solution by the fluids of the body while compression is under way, are liberated in various parts of the body when the men are decompressed too rapidly. The amount of gas taken up by the tissues during the compression period would naturally depend on the length of time the subject is under compression, and the pressure. The "bends," most frequent of the several symptoms of caisson disease, is marked by pain in the joints, generally extremely severe. If bubbles lodge in the blood vessels of the lungs a partial obstruction is caused, and the patient suffers from a form of the disease commonly termed "chokes." Vertigo, commonly known as "staggers," is most often caused by air bubbles in the brain, or in the middle ear. Collapse, followed by death, is caused by quantities of free air in the circulation.

The process of decompression consists in bringing the tunnel worker back to normal air pressure by way of the air locks. If this decompression takes place too quickly, symptoms frequently are manifested. The situation has been compared to the opening of a bottle of effervescent wine or water, when, if the cork is suddenly drawn, the bubbles of gas rise quickly to the surface and are liberated with great force. On the other hand, if the cork be drawn carefully, and the latent effervescence be permitted to escape slowly, the liquid will remain undisturbed.

A MEDICAL JOKE

In this connection, an amusing story related by Hill in his book "Caisson Sickness" is of interest. Certain commissioners who went to celebrate the completion of a tunnel took some highly carbonated ginger ale into the compressed air chamber. Owing to the compression, when the cork was drawn the liquid proved flat, and, thinking it bad, all except one refused to partake. The latter, being thirsty, drank half the bottle, which he then corked and put into his pocket. During decompression in the air lock the cork of the bottle blew out with a loud report, causing much excitement, one commissioner believing he had been shot. This was nothing compared with the disturbance caused within the anatomy of the commissioner who had partaken.

At this writing, the air pressure on the Whitehall-Montague Street tunnel is 33 pounds while that on the Old Slip-Clark Street tunnel has been reduced to 17 pounds as the tunnel headings have met. Before the meeting of these headings, a maximum pressure of 37½ pounds was reached. The pressure on the 14th Street-eastern caissons which are being sunk in advance of tunneling has reached 39½ pounds, but, eventually, after tunneling has been started, the pressure will probably reach a maximum of 45 pounds. On the 60th Street tunnel work no pressure has been used as yet, but ultimately, it is expected that the pressure on this work may reach 50 pounds, the highest yet used in tunnel work in New York City.

EXPERIMENTS SUCCESSFUL

Up to the time that the air pressure had reached 21 pounds, which is a relatively light pressure, the engineers and physicians in charge of the work were not in a position to determine whether the precautions which had been taken to minimize compressed air illness were to prove effectual. But, as the pressure was raised above this point, and no serious results followed, it became fairly certain that the new requirements would prove to be the solution of the problem. Up to the present time there have been more than 700,000 decompressions, and it is believed, from the results thus far obtained, that it is possible to work with safety under a pressure in pounds considerably in excess of the limit now fixed under the New York State labor laws, provided the working shifts and time and method of decompression are properly adjusted.

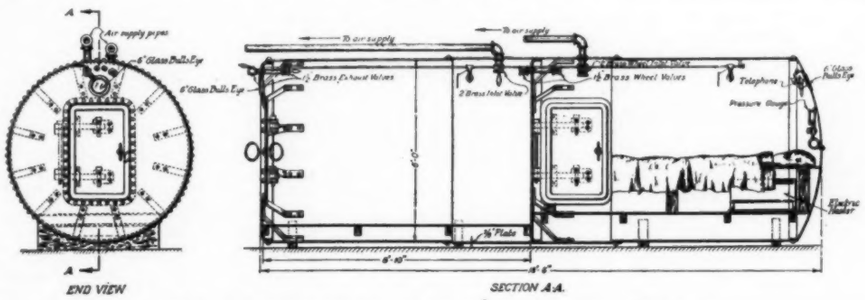


Fig. 1—End view of exterior and side view of interior of medical lock

To date, there have been recorded only 304 cases of "bends" during the construction of the new East River tunnels under the supervision of the Commission, over a period of two and a half years of compressed air tunneling. If this record be compared with the records handed down from some of the earlier tunnel projects in New York City, one of which shows 179 reported cases of "bends" in three weeks, it will appear that considerable progress has been made in the elimination of compressed air illness among the workmen. In comparing records of this character, it must be constantly borne in mind that the number of reported cases of "bends" is far below the actual, as the workman, unless he is in such physical pain that he must seek relief, attempts to keep his record clear and conceals his ailment, as repeated cases of "bends" would tend to show him unfit for the work, and might result in his being disqualified, especially under higher pressures. This record is a true record as far as can be obtained from a most careful supervision of the men upon their exit from the tunnel headings, and it is probable that there have been numerous slight attacks which have not been brought to the attention of those in charge. This, however, is no more true of this work than any other work of a similar character.

ONE FATAL CASE

Only one case of compressed air illness on this work has proved fatal, which, in itself, establishes a very

*From the *Public Service Record*, New York

remarkable record. In this one instance, the physicians and engineers are confident that the life of the workman undoubtedly could have been saved had he, immediately after leaving the compressed air lock, notified someone in authority that he was ill. His condition was not discovered until an hour and fifty minutes after he had left the lock. Emergency treatment applied at that time was not effective owing to the destruction of tissue which had taken place during the intervening period. Investigation made of this case developed a question as to whether this man took the full time for decompression as prescribed by the regulations.

It has been customary, as in other recent work, to treat the men in the hospital lock, as shown in Fig. 1. This treatment has consisted of recompressing the men to the same pressure as that obtaining within the tunnel headings, reducing to the half pressure mark, comparatively slowly. Thence on, the reduction is very slow until atmospheric pressure is reached. This method has generally proved effective, unless the patient has been out of the tunnel for a long period, when the response to treatment, as a rule, is not so ready.

In the opinion of the engineers and physicians on the work, the great freedom from "bends" has been due primarily to the very careful medical examination of the workmen, to the shorter working shifts now enforced, and to the rigorous enforcement of the method of decompression. In particular, probably the greatest factor has been the requirement that the men pass through the intermediate chamber when the air pressure has exceeded 22 pounds. This method of decompression is a modified form of stage-decompression. It is recognized as the most effective method for decompression that has been in use.

DETAIL OF METHOD

The intermediate chambers have averaged about eight hundred feet in length, and it has been customary for the men to come out of heading through the first lock into this chamber as rapidly as they desired. But, after walking through the intermediate chamber after the first decompression and entering the second lock, the time required for decompression in this lock has been the full period which would have been required if the men had come directly out of the headings, without the preliminary decompression. In this way, the time consumed in decompression has considerably exceeded that prescribed by the New York State labor laws.

The great difficulty in handling men who are working under compressed air is to make them feel that the precautions which are required by those in charge are not mere unnecessary hardships but are for their benefit. The ordinary workman adopts the attitude that all requirements as to time and manner of decompression are a needless precaution and are uncalled for obstructions to his exit from the tunnel heading. Consequently, a careful watch has to be kept over the men in order to make certain that they do not decompress too quickly, by slipping out through one of the material locks. It has been found necessary to maintain a watchman on duty at each lock to check off each man as he enters and leaves the tunnel heading, thereby obtaining a record of the time taken in decompression. In this way, and this way only, can proper decompression be insured.

From the experience thus far obtained on the work, it is felt that the dangers of compressed air illness can be largely eliminated in the higher pressures, provided the proper precautions are observed. In this connection, the labor laws require that in decompression the air pressure in the lock shall be decreased at the rate of three pounds every two minutes, unless the pressure is over 36 pounds, in which event the decompression shall be at the rate of one pound per minute. In addition, the following requirements are fixed as to the hours of work in each 24 hours under compressed air:

Pressure in lbs. above atmospheric	Hours in working shifts
0—22	8
22—30	6
30—35	4
35—40	3
40—45	2
45—50	1½

COMPLIANCE WITH LAWS

Each of the above shifts is divided as required by law into two parts, with an intervening rest period outside the tunnel. The length of the rest period varies one-half hour at the lowest air pressure to five hours at the highest pressure. It is apparent that the number of men required to carry on the work in the tunnel headings increases very rapidly with the increase in air pressure. It has been found advisable in decompression to have the locks sufficiently large to permit the men as much freedom of movement as possible, as exercise stimulates the circulation, and helps to eliminate the nitrogen from the tissues.

Regular tests have been made of the air in the tunnel headings in order to determine the amount of CO_2, the temperature and the saturation of the air, but, from observation of the results of these tests, and the number of cases of bends, the physicians are convinced that the amount of carbon dioxide thus far found has no effect on the number of cases of "bends." But the number of cases of "bends" has been found to increase markedly as the air pressure has been increased and the length of the shift remained unchanged.

Each time the shift has been shortened, although the pressure has been increased, there has been a distinct decrease in the number of cases of "bends" reported. For instance, with two 3-hour shifts at 29 pounds, the number of cases of "bends" reported was 93 in 43,000 decompressions, while at 30 pounds, with 2-hour shifts, the number of cases of "bends" reported was only 13 out of 23,000 decompressions, showing that it would not be advisable to increase the number of working hours beyond those which are now in effect.

FUTURE OUTLOOK

Although the work at the present time is far from completed, and as yet no experience has been had with pressures above 37½ pounds, it seems safe to assume that the record has been all that could be desired; and there seems no reason why it should not be continued under the high air pressures which will be required on the 14th Street and 60th Street work. Complete records are being kept of all the data which appear to have any bearing on the study of compressed air illness, so that, at the completion of this work, the information obtained will be available for future tunnel enterprises.

In conclusion, the writer desires to state that this excellent record has been made possible only through the hearty coöperation of the Commission, its engineers and the contractors' organizations. In particular he desires to express his appreciation of the invaluable assistance of Commissioner Whitney, who as Secretary, and later as Commissioner, has endeavored in every way to provide for the needs of the work, and also to Tunnel Engineer Clifford M. Holland, who has given much of his time outside the great engineering problems involved, to the study of this feature of the work, with which the writer is connected.

Irrigation Works on the Blue Nile

THE requirements of the Sudan will be provided for by the construction at Sennar, 120 miles from Khartum, of a weir across the Blue Nile, and by cutting a main canal—excavation work on which has already been started—which will take off upstream of the weir and lead to a point where the water will be delivered to an area of some 300,000 acres. This is as large an area as it is at present considered to be an attractive commercial proposal to cultivate. One part of it will lie fallow every year, one part will be put under green crop, and at least 100,000 acres will be sown with cotton. It has been conclusively proved that cotton can be grown as a winter crop in the Sudan, which means that winter water only will be required for its fertilization, and it is therefore possible to guarantee a sufficient supply without detriment to Egypt. The greatest discharge in the river estimated as necessary for the development proposed is less than the lowest natural discharge recorded in the river at the critical period, and it will be possible to continue the required supply artificially, even if the river should fail altogether. Absolute failure has never been known on the Blue Nile, but its occurrence must be reckoned as a contingency, though even if it should occur and last as long as two months it would still be possible to counteract its effects. The design of the weir provides a height capable of dealing with the highest conceivable flood, and, though storage is not the object of the work, it would be possible long before the actucal date of the failure of the flood to impound by its aid sufficient water to meet fully the requirements not only of the 300,000 acres in question, but of considerably more without any assistance from the river during these two months.

When further development has taken place, then during the period of greatest need recourse can be had to storage provided by that time elsewhere on the Blue Nile. Eventually, the Sudan may take a small quantity of summer water. Under the present scheme none is required, and before that time arrives Egypt will have arranged to meet all her summer needs with ample water to spare, for from the nature of any undertaking with this object the least volume likely to be impounded must be largely in excess of her immediate requirements.

As regards the flood requirements of the Sudan, they are relatively small, and, looking ahead as far as reason permits, they will continue to remain negligible. It is true that in the past a certain minimum height of flood wave was a necessity to Egypt, and that her interests would in a bad year have been unfavorably affected by any such reduction of that height as might be caused by the abstraction of water for new areas in the Sudan. But today, with nearly all the land under control so far as flood is concerned, and guaranteed against failure by weirs and barrages, cultivation is no longer vitally interested in the minimum height of the flood. The small remainder still uncontrolled could also be commanded by a weir, so that long before the Sudan can develop such an area as would abstract an appreciable quantity of water, Egypt's little remaining interest in the height of the flood will have disappeared.

In conclusion it is interesting to note two important expressions of opinion, with regard to the irrigation problems before the country, put on record by Sir Murdoch Macdonald. In the first place, he points out that the Blue and White Niles are alike capable of providing additional and ample storage to satisfy the full requirements of all present crops and to allow of their wide extension and development. At the same time it will be possible on one or other or both of these rivers so to control the height of the annual flood wave as to prevent its height and duration from causing danger to Egypt. This control, coupled with the protection of the river banks, will give Egyptian cultivation a permanent assurance against loss by inundation, an advantage that is seriously needed. Secondly, he considers that there are probably no serious technical difficulties in the way of completing the principal irrigation and drainage projects in a comparatively short period of time; and control of the river with the assurance of a sufficient supply of water for the final limits of Egyptian cultivation at all times of the year, independently of natural conditions, is, so far as the engineer is concerned, a possibility already within sight.—Engineering Supplement of the *London Times*.

Paper Yarns

IN recent years the use of paper yarns of 1–5 mm. diam. in the cable industry has largely increased, chiefly as a partial or complete substitute for jute as a packing between the lead sheath and the iron armour of the cables, for which purpose the paper yarns are specially impregnated before spinning. In the coating of lead-sheathed cables with waterproof composition, also, the winding of paper yarn serves as well as the old jute yarn winding, since it adheres better to the lead sheath and blends with the composition to form a perfectly flexible and waterproof covering. Paper yarns spun from parchment paper are used for weaving driving belts for light machines up to about 8 horse-power, in widths of 30–155 mm. and thicknesses of 5 and 7.5 mm. The yarns are spun, impregnated, wound on spools, and the fabrics woven from them are stitched together to the required thickness. The effect of treatment with various chemicals has been studied. A solution of aluminium acetate partially neutralized with sodium carbonate imparts a somewhat harsh feel but causes no cohesion of the threads; subsequent treatment in soap solution produces a flexible damp feel and prevents the absorption of water, but does not appreciably improve the strength after immersion in water. Gelatin solution mixed with neutralized aluminium acetate cements some of the threads together and causes a decrease in strength of 17 per cent, but reduces the loss of strength in the wet state. Gelatin mixed with formaldehyde imparts a milder feel and does not cement the threads; in this case the decrease of strength is only 8 per cent, but the loss of strength in the wet state is not reduced to so great an extent. Treatment with 1 per cent tannin solution gives a soft, pliable feel and increases the strength by 49 per cent and also has a favorable influence on the strength in the wet state. Tannin solution fixed with gelatin gives a hard, string-like feel, increases the strength by 25 per cent, and reduces the loss in strength on wetting to only 15 per cent. Tannin solution fixed with neutralized aluminium acetate gives a strong, elastic feel, the strength is increased by 44 per cent, and the loss of strength in the wet state is 22 per cent. Weaker tannin solutions have a correspondingly weaker effect. Paper yarns come into the market containing a considerable excess of moisture as a residue from the spinning process; this is not necessarily a drawback because the moisture imparts a flexibility favorable to the working up of the yarn into finished goods. The average of a large number of analyses showed a total moisture (natural and excess) of about 38 per cent; the highest value found was 65 per cent. Pinagel (*Monatsschr. Text. Ind.*, 1916, 31, 146) has proposed, as a result of his investigations, that an addition of 14.66 per cent to the dry weight be taken as the basis for the calculation of the commercial weight of paper yarns.—Note on an article by W. MASSOT, in *Z. Angew Chem.* from *Journal of the Society of Chemical Industry*.

Shall We Eat Corn Meal?

A Question of World Economics

By M. Helen Keith, Assistant in Animal Nutrition, University of Illinois

FROM the point of view of the world economics we are urged to substitute corn, rye, barley, buckwheat, etc., for much of our wheat this year. Mr. Hoover, in his appeal to the housewives, calls for one wheatless meal a day. The wheat crop of last year in the United States was smaller than usual and the winter crop this year was a failure in large sections. In spite of an increase in the planting of spring wheat there is no prospect of a total wheat crop which shall much more than cover our usual home consumption. But it is said that our Allies will need at least 200,000,000 bushels of wheat from us this year. Where is it to come from? Evidently only from self-restraining economy on the part of everyone. As a matter of common humanity, therefore, we should take our part by willingly giving up some of our wheat for the other cereals. Probably for most of us corn meal and hominy will be a natural substitute.

As a matter of fact, with flour costing sixteen dollars a barrel and the ten-cent loaf of bread or box of crackers selling at fifteen cents, the family pocket-book makes the same demand. Corn meal is cheaper than flour.

From the point of view of the supply of corn, also, such a substitution will be an advantage to the country. Ordinarily the quantity of corn produced in the United States is from three to four times the quantity of wheat, but only from 5 to 10 per cent of it has been used for human food. Owing to the agitation made this spring, about 15,000,000 acres more have been planted to corn this year than last. An effort is being made also to spare a larger proportion for human food by the whiskey prohibition and by the employment of other feeds for stock. Most of the increased use should be by consumption in our country rather than by exportation, because wheat keeps better for exportation than corn does; and, further than that, the peoples of most other countries have not become accustomed to eating corn as our people have, and they are wheat eaters.

The economist, the producer, and the family pocket-book, therefore, are all urging a rather general substitution of corn for wheat in the diet. But what about the nutritive value of corn meal? Is it perfectly safe from that point of view to make the substitution? It will not be economy to use it if the family health is to suffer.

There may be hesitation on the part of some who have learned that stock-raisers have long looked upon corn as an incomplete ration for growing animals, also that pellagra is especially prevalent among peoples that habitually eat a great deal of corn meal and that the diseased condition has been attributed to that habit. Such facts make one stop and ask for the most authoritative evidence as to any possible explanations for them and as to how far they should influence one against the use of corn in its various forms for the family and for the stock.

The nutrition laboratories have already investigated these questions in several directions in behalf of the public and are glad to help the public now in meeting them. Repeated experiments with animals support the conviction that corn is not a complete ration for young animals and that a diet consisting almost entirely of corn meal is more than likely to result in a stunted growth and in disease. Rats and monkeys kept on restricted diets of this kind show nerve and other tissue changes much like those found in pallagrins.

In the study of the possible causes of these ill effects, it is found that among the proteins extracted from various sources the proteins of corn are relatively unsatisfactory for the important task of tissue building. The principal protein of the corn grain is zein, and zein is an incomplete protein in the sense that it does not contain all of the units which are required for maintenance and for growth. Although the other proteins present make up for a part of this lack, yet it is evident that the protein defect is a reason for the inadequacy of the corn grain as a whole. The exact nature of the defect has been studied until it is known just what protein units are lacking, and that if those units are added in other ways to the diet the corn is satisfactorily supplemented, so far as the protein is concerned. Corn, therefore, is deficient in protein value as compared with some foods.

Another pronounced deficiency of corn which has been detected is in the so-called "mineral" constituents—the salts—which are necessary chiefly for building the bony structure and maintaining the character of the body fluids. An ideal mixture of mineral salts is, for example, such as is found in milk or in hens' eggs. What one article of the diet lacks others must supply; the only parts in any danger of being insufficient are calcium and phosphorus for bone and for blood and iron for the blood. Corn has a low mineral content generally and is especially lacking in calcium. Corn used as the sole food for growing swine, for example, must have a calcium salt added or the bones will be weak and deformed. Corn is more defective in this respect than other grains, and the milling of the meal, which removes the bran and most of the germ, further decreases the mineral content.

So far as investigation has shown no complaint need be made against the carbohydrate or the fat of corn meal; those dietary accessories, the so-called vitamines, which are fascinating certain workers now-a-days—elusive as to their chemical nature, but convincing enough as to their indispensability in nutrition—those cannot all be obtained from corn meal in sufficient amount for perfectly normal life including growth. The amount of one at least is low, one which is associated with animal fats and is supplied in butter fat. Among vegetable foods this constituent is furnished more adequately by the leaves of plants than by the seeds. The more common grains, all being deficient in this fat-soluble factor, cannot any of them with impunity be used as the sole diet for man or animal. Here, then, is a third defect of corn meal.

With regard to pellagra, the investigators are not yet satisfied as to the specific cause of the condition; but there is no question that it is associated with malnutrition. All of the defects of corn which have been mentioned and others less substantiated have each been charged with the responsibility of producing the disease, but it may occur with an excessive use of wheat flour as well, or with other very restricted diets mainly vegetable. It is relieved by a change of diet which reduces the amount of carbohydrates and introduces animal products, especially meat. There is some evidence that it is an infectious disease in which the malnutrition is but a secondary cause. The two chief views held are: first, that it is due to a lack of the food accessories called vitamines, and, second, that it is due to an infection. Neither is proved. Whatever may be the direct cause of pellagra, however, it need not be feared from corn in any of its forms when introduced into a mixed and otherwise adequate diet.

With that we come back to the summation of the whole situation. It is true of each of the three points found against corn, as well as of any other possible point which comes out in pellagra, that it is very readily counteracted by other articles in the diet. In fact, the single item of milk alone might make up for them all: The lack in the corn protein (zein) is well supplied by the milk proteins (casein and lactalbumin); the mineral lack is met by the minerals of milk; and the fat-soluble accessory is found with butter-fat. Corn meal has its defects, and they are somewhat greater than those of wheat; but they are abundantly overcome in a dietary which includes milk and eggs, fresh fruits and vegetables, and some meat. They are not of such a nature as to constitute any argument against corn bread with the dinner and corn-meal mush or hominy with the breakfast.

As a matter of fact, therefore, after making out the worst case we can against the corn, we decide that it is a perfectly good and wholesome food to introduce into the general dietary, and that scientific investigations as well as economic demands justify the substitution this year of as much corn meal as possible in place of wheat flour.[1]

[1] The reader may be interested in the discussion and the recipes found in Farmers' Bulletin Number 565, entitled Corn Meal as a Food and Ways of Using It. Send to the Division of Publications, U. S. Department of Agriculture, Washington, D. C.

A Telescope as a Seismograph

IN a region of little or no cloud can a telescope be adapted to serve as a delicate seismograph? Professor E. C. Pickering, of Harvard, has designed a meteorological instrument known as the Pickering Pole Star Recorder, which, by taking a continuous photograph of Polaris at night gives a basis for estimating the amount of cloudiness which has occurred. As Polaris is not exactly at the north celestial pole, the star's image focussed upon a photographic plate will make a semicircle on cloudless nights, broken on partly cloudy nights, and entirely absent on overcast nights. At least three of these instruments are in successful operation in New England at the present time. Though not intended as a seismograph, would not an earthquake record itself upon the sensitized plate also? It seems a comparatively simple matter thus to transform a small and inexpensive telescope into a sensitive seismograph. This idea was suggested by the following note, submitted by Mr. Wendell P. Hoge, of the Mount Wilson Solar Observatory in reporting an earthquake of intensity which occurred March 22, 1916:

This disturbance noticed while watching star image in 60-inch telescope, using high-power eyepiece. Oscillations of the star image in the field rapid and short at first, becoming more marked in the middle and diminishing at the end of the disturbance. Evidently a very faint shock. Mr. G. A. Monk, using the instrument a little later, at 4:50 and 4:56 A. M., noticed two very feeble oscillations.—From a paper by A. H. Palmer on California Earthquakes during 1916 in *The Bulletin of the Seismo. Soc. of Am.*

Alcohol from Carbide in Switzerland

ACCORDING to a recent issue of the *Statist*, the leading Swiss hydro-electric concerns as well as the aluminium company, the Lonza, Ltd., have now completed their researches in connection with the production of pure alcohol for industrial purposes from calcium carbide. Industrial alcohol is under Government control in Switzerland. The introduction of this new industry will be the joint work of the Federation and the Lonza, Ltd. In spite of the high prices of coal (a truck load from Germany costs 600 fr.) the Lonza will be able to sell spirit of second quality at £21 2s. per metric ton and pure industrial spirit at £22 4s per metric ton. This is far less than the Swiss Federation pays now for imported spirit. Switzerland will thus become an exporter instead of an importer of alcohol. The installations with about 20,000 horse-power in minimum and 30,000 horse-power in maximum (summer time) will produce annually 7,500 tons of alcohol minimum, and 10,000 tons maximum.—*Journal of the Society of Chemical Industry.*

A Government Fur Farm

AN experimental fur farm has been established in northern New York by the biological survey of the department. At this farm the Government specialists expect to test many kinds of fur animals, foreign as well as native, as to their adaptability to domestication. One of the most important lines of work to be taken up will be that of developing improved strains by selective breeding. This farm is the outgrowth of experiments conducted with minks and martens during the past year at Linden, Md., and the National Zoölogical Park, D. C.

An Arc Light for Projection Lanterns

IN order to produce better results when working with arc lamp projection lanterns which make use of a condenser lens, it is desired to keep the arc in a constant place so that the crater will throw the light always at the same point or at least as near this as possible. A new method for such lanterns makes use of one carbon electrode placed with the crater in the center position back of the condenser lens and the second electrode is of metal which is designed so as to be rapidly cooled off to prevent burning away too fast. The metal is pointed at the end next the arc and farther down it carries a set of expanded cooling wings so that the metal keeps cool in this way. A more effective method is to mount the metal point upon the side of a tube through which a stream of water is kept flowing.

Loom Weaving Among the Igorots

AMONG the Igorots each tribe has its characteristic designs, and the methods of weaving differ. In Benguet, Amburayan, and western Lepanto, the Ilocano loom is used. In northern Lepanto, Bontoc, Kalinga and Ifugao, the Igorot loom is employed. This consists only of a harness and reel held in place by the warp itself. The warp is double and one end runs around a horizontal bar fastened generally between two trees, while the other end is attached to the belt of the weaver. She sits flat on the ground and fills in the woof from wooden bobbins. —*The Philippine Craftsman.*

Avoiding Collisions at Sea*

THE application of this method to the end of avoiding collision at sea involves the means of emitting crisp, and sufficiently loud, sounds in air, which can be timed to coincide in moment of emission with wireless signals, or, in certain cases, with luminous signals. Long-distance wireless signals are not required. A more perfect installation would include the power of emitting and receiving submarine signals.

There can be no serious difficulties in the way of imparting to the signals the quality of simultaneity. Where electric control can be used directly or indirectly the problem involves little more than the provision of suitable clockwork for regulating contacts. Again the degree of skill or intelligence called for in timing the receipt of the signals is not so great as to limit the use of the method to the more highly educated seaman. A very little practice, which can be obtained at any time, will give all the requisite skill in using the stop-watch. With ordinary care to read the successive signals in the same manner, the error in estimating the interval between them will probably be small. This I have already discussed in a former paper. There are, I believe, neither mechanical nor personal difficulties in the way of good determinations of distance between ship and ship.

The means by which the determination of distance may serve to reduce or eliminate the risk of collision I shall now explain. I am fully alive to the fact that to expect of the mariner the solution of complex analytical or geometrical problems, under the conditions of anxiety obtaining on a vessel being navigated in thick fog, would be futile. The following solution of the problem of foretelling whether or no there is risk of collision with another vessel, and if there is such risk indicating the precise time at which the danger is imminent, even under circumstances when the direction of sound in the air cannot be inferred, is so simple that I would hope it may be of use. The diagrammatic nature and repetitional character of the steps required protect it from risk of oversight or mistake.

When two ships provided with the means of determining distance, as described above, become aware of one another's presence in fog—either by the reception of periodically sent out wireless signals or by the usual regulation sound signals—the following procedure would be adopted:

Each ship sends out: (1) a code signal by wireless giving her course; (2) a signal giving her speed; (3) the wireless signal always emitted simultaneously with the aerial sound signal.

These three signals are made in close succession. They are repeated at intervals: (1) and (2) perhaps every 10 or 15 minutes, or when course or speed are altered: (3) at intervals of, say, two minutes.

In this way each ship knows the course and speed of the other ship and on the result of two successive observations of distance the navigator is able to determine the rate of approach or recession of the other vessel. These data are dealt with at the moment by a simple geometrical construction now to be described.

The decision as to whether there will be collision or not turns upon the fact that if the rate of mutual approach of the ships is the maximum for the given conditions of course and speed there will be collision. If they are approaching one another at a rate less than the maximum rate there will not be collision.

The truth of this statement is evident when it is considered that the point of collision (if there is one) is a common point on the line of advance of both vessels: and the speed of each ship is being directed to bring her straight to that point. Hence their mutual distance must be diminishing at the maximum rate for the assigned courses and speeds at every instant. If the ships are not directed towards a common point a certain component of their velocity is always acting to separate them, or, in other words, to lessen their rate of approach. Considered when the ships are approaching end on (suppose one is going north and the other is going south) the statement is obviously true; for only when they are advancing in the same line is the rate of approach a maximum, and then only can they collide. Similarly it is obvious for one ship overtaking another on a common course. The general statement perhaps needs more consideration. It will presently be more fully set forth.

In Fig. 1 let one ship be going north. This ship we will call A. Her speed is such that she occupies at successive intervals of two minutes the positions 0, 1, 2, 3, etc. These are, therefore, her positions when receiving the successive signals from another ship we will call B.

When A is at the point 0 she receives the first signal from B, to the effect that B is holding, say, a southeast course at a speed of n knots per hour. The distance signal shows that B is at a distance of d_0 knots.

*An abstract from an article by Prof. J. Joly, F.R.S., in the Proceedings of the Royal Society, London

The navigator on the A strikes a circle with the point 0 as center and with the radius d_0 taken to the same scale as he used in setting out the points 1, 2, 3, etc.

As no reliance is supposed to be placed on the fancied directions of sounds from B, nothing more is known on A beyond the fact that B is somewhere upon the circle having the radius d_0, and marked d_0 upon the diagram.

Laying off from the point 0, a line bearing southeast, the navigating officer on A lays off from 0 along this line, and still to the common scale, a few points giving the displacement of B on her course every two minutes. With these points successively as centers, he strikes the circles I, II, III, etc., to the common radius d_0. He knows that B will be transferred from one of these circles to the next in the course of successive intervals of two minutes. This is true, no matter where she is placed on the first described circle. He now awaits the second signal from B giving her new distance.

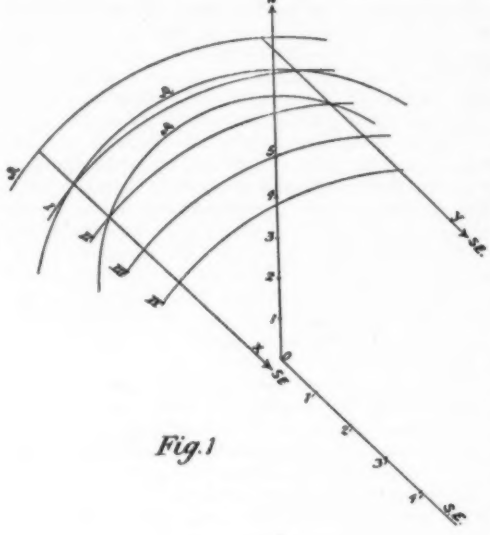


Fig. 1

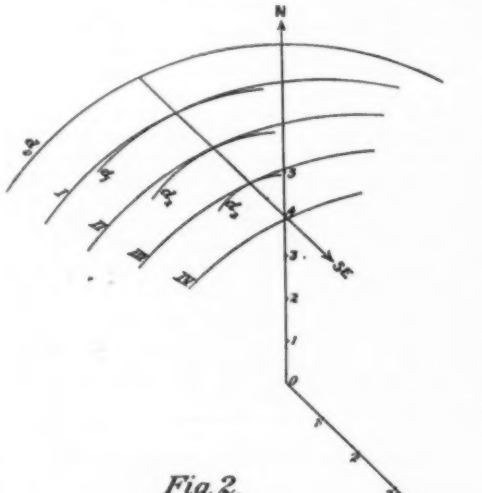


Fig. 2.

Fig. 3

The new distance is d_1 knots. If d_1 is greater than d_0, the vessel B is evidently receding from A, and must occupy some place on the southeast half of the circle I. To prove this it is only necessary to take the distance d_1 in the compass and with the new position of A as center, that is to say, point 1 on the course of A, to cut the circle I. The two points of intersection will lie on the southeast half of circle I. One or other of these points of intersection must be the position of B. Hence, when d_1 is found to be greater than d_0, the observations need not be carried further.

If d_1 is less than d_0, B is approaching A. In this case a circle struck with d_1 as radius (always to the common scale), and the new position of A as center (*i.e.* point 1), in general intersects circle I in two points. These points are in the northwest half of circle I, and in one or other of them B must be located at the instant. For these points are the only points common to circle d_0 and circle I, and we know she is on both circles.

The arc d_1, in place of intersecting circle I, might touch it only, *i.e.* be tangent to it. In this case we get but one point on circle I. This unique point is the position of the ship B.

If the arc d_1 intersects circle I there is no risk of collison. If it touches it only there will be collision.

In stating the result in this definite manner, we assume quite accurate conditions and measurements. Some error there must be, however, and, from the practical point of view, it is only correct to affirm that, if the circle to the radius d_1 clearly cuts the circle I at two points so that the result is beyond the limits of error, there is no risk of collision, while, if it touches it, or within the limits of error might touch it, there is risk of collision.

In the case where there is intersection, and a line bearing southeast is drawn through each point of intersection, the ship B is advancing along one or other of these lines, marked X and Y on the diagram (Fig. 1). The mariner cannot distinguish which of these lines she is on, either from this or from succeeding observations. He can only so do by altering his course and testing the results as to distance. But this is of no importance. In general, if he knows he is clear of the other ship, it is all he cares about.

Considering the result that there are two possible lines of advance for B when d_1 gives us two points on circle I, we recognize that there cannot be two lines of advance leading B into collision with A, that is to say, leading to one particular point on the line of advance of A. For the two lines holding the same course are parallel, and hence cannot meet at a point. This is proof of the theorem that if the arc struck from 1 to the radius d_1 meets circle I on two points, there cannot be collision.

While it is true that if collision is not going to occur, there are two possible lines of advance for B, it is also true that if collision is going to occur there is but one line upon which B can be advancing. This unique line of advance is determined when the arc d_1 is tangent to circle I (Fig. 2). For we have only now to draw a line bearing southeast (the given course of B) through the point of contact of arc and circle. Where this line cuts the successive circles II, III, etc., the ship B will find herself in the succeeding intervals of three minutes. If we follow the advance of B upon the diagram in this way, and compare the successive positions of ship A, we will find that both vessels meet at a common point of advance. In order to fix with more precision the position of this line of collision, join the points 1 and 1′, and proceed to intersect circle I. This gives the point of tangency when the arc d_1 touches the circle. It is well to check the position of the collision line by also joining 2 and 2′, and 3 and 3′, and intersecting the circles II and III with the lines so found.

Before proceeding further we may revert to our original statement that the line of collision may be defined as that of the maximum rate of approximation of A and B. Our construction is based upon that fact. For when d_1 gives a tangent arc it is evidently the least distance which conforms to the condition that the second position of B is on circle I. Hence the value of d_1 is the least possible, and it follows that the rate of approach of B to A has been the greatest consistent with the conditions of course and speed. Similarly we see that if d_1 intersects circle 1 a greater value of d_1 than the minimum is involved and therefore the rate of approach of B to A is not the greatest; that is, it is not so great as when there is a line leading to collision.

Having ascertained that there is risk of collision with B, the navigator can, if circumstances permit, continue to observe the approach of B upon the diagram and thus confirm the first inference. If the successive arcs d_2, d_3, continue to indicate risk of collision, according to the rules of the road the vessel B keeps out of the way of A.

On the question of the usefulness of this method we have two considerations before us: the reliability and definiteness of its indications and the degree of facility with which it can be put in execution.

Regarding the first point, the method proposed claims to tell the mariner (1) whether there is risk of collision or not, and (2) the probable moment of danger if collision is threatened. These claims are undoubtedly justified, although certainty in the prediction of collision is unattainable, for the simple reason that perfectly accurate estimates of speeds, courses and distances are unattainable. But *risk* of collision is foretold. In Fig. 3 possible effects of error are shown. We here assume that large errors of distance, of the same sign, have affected the observations throughout. Tangent arcs have become intersecting arcs. The distinction between this and the case of Fig. 1 is obvious. For error of observation is not cumulative. Each determination of distance is an independent observation. Hence the successive arcs, d^1, d^2, etc., are separated by similar radial elevations above the arcs they intersect. Such a feature at once warns the mariner that the intersection is not real. Under conditions of safety each observation shows an increasing departure from the conditions of danger, the separation of the arcs getting more and more pronounced. The diagram, in fact, faithfully interprets the external facts, for, of course, lag in the approach of the ships behind that of maximum rate of approach constantly adds up, the evidence for safety becoming more apparent in successive observations.

Hence the method tells the mariner whether there is risk of collision or not.

It also tells him the moment of danger. This is obvious. For the given courses and speeds the point of collision is fixed. Of course, currents and tidal drift might affect the ships differently. Or, again, speeds or courses might vary. It can only be answered that some latitude must be allowed for these things. It may be noted that error introduced into position of the circles, I, II, III, etc., due to these causes may be checked at intervals, if time permits, by treating any of the distance determinations as originating a succession of circles of position. If the ship B was a long way off when the first signal was received precision would be gained by this procedure. It is, of course, quite simple. We start a new diagram, say, with d_5 and with the nearest coinciding statement of B as to her course and speed. The construction already described is then repeated.

On the second point, the facility with which the observations are carried out, it must be remembered that all the arithmetical work of determining the distances to be scaled off on the diagram can be eliminated by the use of tables. Quite brief tables would suffice. If B signals that her speed is 12 knots the navigator on A reads at once from his tables what this amounts to in three minutes, or whatever other interval exists between the signals. His scale is, say, 1 knot to the inch. The tabulated number is taken up off a scale of inches divided to tenths. In laying off bearings time is saved by using paper divided to compass points around a central point. He lays the course of his own ship through this point. The bearing of the other ship being given, he at once plots it. The rest consists in describing a few circles and joining a few points. The practical seaman must judge for himself how far this procedure is repaid by the security gained.

A Workshop Method of Determining the Refractive Index of a Block of Glass, of Which Only One Face Is Polished*

By Dr. Reginald S. Clay

THE method is based, as are the Abbe and Pulfrich refractometers, upon the determination of the critical angle when light passes from the medium of which the refractive index is to be found, into one of which the index is known. The hemispherical ball of the Abbe, or the cube of the Pulfrich, refractometer is replaced, in my case, by an isosceles prism, which, in the instruments shown, is an isosceles right-angle prism. This must, of course, have a higher refractive index than that of the substance it is required to measure. Mine has the value 1.7172. A simple telescope, composed of two spectacle lenses with a cross-wire at their common focal plane, is used to take the readings. A drop of liquid of high refractive index (I use *Quinoline*) is placed on the hypotenuse face of the prism, and this is placed upon the polished face of the glass of which the refractive index is required. Sodium light is caused to fall on one side of the block of glass, and the light emerging from one face of the prism is received by the telescope. The latter is turned until the critical angle is obtained—shown by one-half of the field of the telescope becoming black—the dividing line of the field should be on the cross-wire of the telescope. The observation is repeated for light falling on the opposite side of the glass block, and emerging from the other face of the prism. The angular distance between the two positions of the telescope will give the refractive index of the glass. The scale can be divided to give the refractive index directly, or if it is divided into degrees, a curve can be drawn to give the refractive index when the angle is known.

A diagram, Fig. 1, will make the description clear. S is the sodium flame. The ray S*p* parallel to the surface passes through the layer of liquid to Q, through the prism to R, and emerges along RT. In the second position, the light from S′ passes along S′*p*′Q′R′T′. The angle between RT and R′T′ is found.

It is not difficult to see how the value of n, the refractive index of the glass, can be calculated when n_0, the refractive index of the prism, is known. For in Fig. 2, if MQR, the critical angle from the glass into the prism, is denoted by r_1, and the angles the ray makes with the normal NN to the surface AC be denoted by r and i respectively, we have

$$n = n_0 \sin r$$
$$\sin i = n_0 \sin r$$
$$\text{and } r_1 = 45 + r$$

Also, if θ is the angle between the two positions of the telescope, *i.e*, between TR and T¹R¹ in Fig. 1, $\theta = 2(45+i) = 90+2i$. Taking θ to be 110°, 120°,. . . . 220°, i will be 10°, 15°,. . . . .65°. Subtracting the log. n_0 from the log. sin i will give log. sin r, and therefore, r. Add 45° to r to get r_1, add log. n_0 to log. sin r_1, which gives the log. n. The calculations should, of course, be tabulated. They should be carried to five figures.

A new scale can now be made, giving the refractive index directly. All that is necessary is in taking the reading s to bring the zero of the scale round to coincide with the index attached to the telescope when it is in its first position TR, and then the scale will give the refractive index n, when the telescope is in its second position T¹R¹.

A small block of wood painted dull black is placed at W (Fig. 1), when taking the reading TR, to cut off any light coming directly through the prism, or reflected at the hypotenuse face. This block is moved to the other side of the prism when taking the reading T¹R¹.

The scale is a very open one, for instance, with my prisms θ changes from 110° for $n = 1.3423$ to 220° for $n = 1.6722$. In the middle of the scale 3° changes the second figure after the decimal point by one unit. As a tenth of a degree can be estimated, it is easy to see that even with a home-made apparatus and no vernier, the third figure beyond the decimal should be correct.

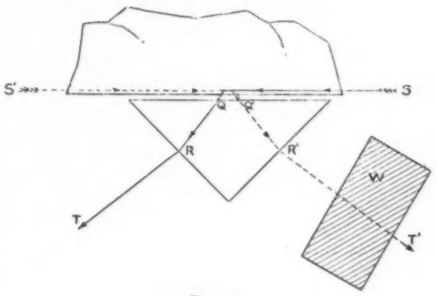


FIG. 1.

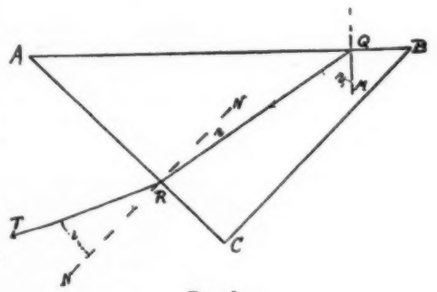


FIG. 2.

If only rough readings are wanted, a scale can be constructed experimentally by observing the angle between the two positions of the telescope with four or five specimens of glass of known refractive index, plotting the deviations obtained against the known indices, and then drawing a smooth curve through the points obtained. Even in this way there should be no difficulty in getting the third decimal within one or two units.

For my telescope I have two tubes, one about four inches long, which slides in another about eight inches long. An eleven diopter lens is mounted in the end of each, and a cross-wire in the focal plane of that in the longer tube—the objective. It is adjusted until there is no parallax between it and the image of a distant object. Then the lens end of the shorter tube is inserted in the end of the longer, and adjusted until the cross-wire is in focus. Thus the eye is about four inches from the eye-lens. The other end of the telescope should be about three inches from the prism, so that the eye and the prism may be conjugate with respect to the telescope.

*Transactions of the Optical Society, (London).

Rust Prevention in Ferro-Concrete

THE prevention of the rusting of the iron which is embedded in concrete for reinforcing it would be a simpler problem if concrete rich in cement, and thus in the lime, which protects the iron, did not incline to crack in shrinking. Once moisture gains access to the iron, the iron rusts and swells and in expanding cracks the concrete, and it is difficult afterwards to distinguish between cause and effect. In some laboratory tests the specimens can be kept free of fissures, and the results may be more satisfactory than in practice for that reason. If the iron could be made and maintained passive, rust formation could be avoided. It has long been known that chromic acid and soluble chromates will render iron passive, and a certain use is made of this property for the protection of boilers, circulation pipes and liquids, and when emulsion is wanted for cooling and lubricating on the lathe. There has also been some experimenting on concrete mixed with chromate solutions. An interesting contribution to this problem was published in the *Schweizerische Bauzeitung* of February 10th, 1917, by Mr. B. Zschokke, of the Swiss Station for Testing Materials at Zürich. Zschokke uses potassium bichromate in two ways. He either mixes the cement with chromate solution instead of water, or he prepares a paste of Portland cement, sand and solution of bichromate in different concentrations, and paints one face of iron plates with this paste, the edges and back being painted with asphalt varnish. In the latter case the moisture should not be less than 50 per cent., else the hardening crust of concrete on the iron will peel off. The specimens are sprayed over with water containing carbon dioxide for the first five or six days; afterwards they become so hard that the concrete crust cannot be knocked off with a hammer. These specimens were exposed, together with ordinary cement specimens, for months in partly covered dishes, in which they rested on dry supports over water. The specimens prepared with ordinary water rusted very badly, in all cases, while the chromate plates kept perfectly free of rust and of cracks. In other tests round irons, 18 mm. in diameter, were coated with a layer of cement and calcium or potassium chromate, which hardened in a day, and were then placed in a mold, the empty space being filled with concrete. In other tests, again, pieces of sheet iron were coated with ordinary concrete or chromate concrete, and lines were then scratched into the coating, exposing the bare iron; the rusting spread from these scratches in the ordinary concrete, but not in the chromate concrete, and other experiments confirmed the conclusion that the chromate protection will extend over small exposed spots. As the special painting of the iron with chromate concrete might be objectionable, the whole concrete was, in the other series, prepared with a 5 per cent. solution of potassium; the results were equally satisfactory. There remained the question whether the addition of chromate impaired the strength of the concrete or delayed the setting; there was no delay, though possibly a very slight decrease in the strength; in some cases an increase in the strength was observed. A chromate-concrete would cost from 3 per cent. to 5 per cent. more than an ordinary concrete, Zschokke estimates. He has applied for a patent, and although the basic idea is certainly not novel, it is quite conceivable that its application to building and engineering structure may form good subject-matter for a patent. The cost might possibly be reduced by diminishing the proportion of chromate; in aqueous solutions less than 1 per cent. of dichromate suffices to render the iron passive. The serious drawback, to which Zschokke himself directs attention, is that the chromate protection fails in the presence of certain common salts, alkali, chlorides and sulfates, and also of considerable amounts of sulfurous acid vapors; the process could not be recommended, hence, for sea-water and acid atmospheres. On the other hand, the painting of iron pipes, etc., with chromates and other suitable materials should be further studied.—*Engineering.*

The Wireless Storm Detector*

Its Influence Upon the Operation of Lighting Central Stations

By W. H. Lawrence[1]

Such public utilities as those supplying gas and water are fortunate in that the commodities they distribute are physical materials. During those parts of the day when the demand for their product is small, the excess delivered from the station can be economically stored in a reservoir for use at later periods in the day when the demand is greater than the capacity of the station.

The public utility that distributes electricity, however, cannot be modeled profitably after this plan on account of the properties of the commodity that it handles.

Electricity, like light and sound, is not a physical material and therefore can exist only as long as the influence of its generating source continues. This property renders it impossible to directly store or preserve electricity for future use. Although such an end may be indirectly accomplished by the use of storage cells, which convert the kinetic energy carried by the current into potential chemical energy and later carry out the reconversion, the efficiency of this method is very low. For this reason, the use of storage batteries in supplementing the generation of electricity has been restricted to such purposes as involve the furnishing of a reserve to safeguard the service against interruption when some accident temporarily affects the generating, transmission or transforming systems.

Electrical stations, being unable to economically avail themselves of the use of a reservoir which may be charged with the excess energy of the station at light load periods and discharged to assist the station at the heavy load periods, have to be designed with a capacity equal to no less than the maximum demand upon them. This factor of an installed station capacity at least equal to the maximum peak load is the greatest financial handicap to which an electrical station is subjected. That this condition is unavoidable has long been recognized and accepted by our business men and engineers.

Since it is only during the peak load of the day that the whole equipment of the station is working, it is evident that the return on the entire investment during the remainder of the day must be earned by that portion of the equipment that is then operating.

This is a condition that makes it highly imperative that an electrical station be operated with maximum economy throughout the entire day. Given a certain station equipment, this is mainly accomplished by a strict adherence to a regular daily routine. Thus, at any period of the day only that number of machines is operated which is sufficient to economically carry the load then existing. At times of light load or average load, a steam-driven station will have a large share of its boilers "banked" and a number of its generating units idle. When under such a condition a large unexpected demand for an increased output may be made so suddenly that the number of machines which are operating will be insufficient to carry the abnormal demand, and it is probable that the standard of service will be lowered until such time as reserve boilers and generating units can be brought into service. For this reason it is imperative that the station receive preparatory warning of any abnormal demand.

The rapidly moving clouds which accompany a storm constitute the principal cause for the sudden and unexpected increases in the demand for current from a lighting station.

Any device, therefore, that will provide a warning of the approach of a storm, at a time sufficiently far in advance to enable the station attendants to prepare for the exception to their daily routine in a deliberate and orderly manner, would be most welcome.

The storm detector is such a device.

All summer storms, or practically all of them, are accompanied by electrical disturbances in the ether. These cover a field far greater than that over which the storm clouds themselves are visible. By use of antennae, some of these radiations may be intercepted and by a suitable apparatus be made to give an indication of not only the presence but also the relative proximity of the storm.

The storms that occur during the winter months are usually snowstorms and are of but a weak electrical nature. For this reason, they may perhaps not affect the device. At this season, that is a matter of but small moment. In winter, the load upon the stations during the daylight hours is uniformly greater than during the summer and the demand regardless of the severity of the storm will always be from 20 to 25 per cent less than the demand which occurs daily between 5 and 5:30 p. m., for which the station is always prepared.

This is evident when it is considered that winter storms have no effect on street lighting and other outside lighting, sign lighting, residence and apartment-house lighting, etc., all of which are on at the time of the daily peak at 5:00 p. m. For this reason, winter storms are of such minor importance that the service of the storm detector is dispensed with during that season.

The various parts making up the detector are an aerial, a short-circuiting switch, a spark gap, a coherer, a relay and battery, a bell (which also acts as a decoherer) and battery, a condenser, and a ground connection. Figure 1 shows the diagram of connection of these parts.

Aerial.—Antennae, similar to the more simple ones used in connection with wireless telegraph outfits, have been found to serve the purpose admirably. It is this part of the equipment that receives the ether radiations resulting from the storm.

The oscillating current thus set up travels to and from the ground through the spark gap, coherer, and condenser.

Short-Circuiting Switch.—This switch and its connections are shown in Figure 1. Nominally, it is kept in the "open" position. After the alarm bell has begun to ring continuously, it is closed to protect the apparatus from heavy surges and to silence the bell.

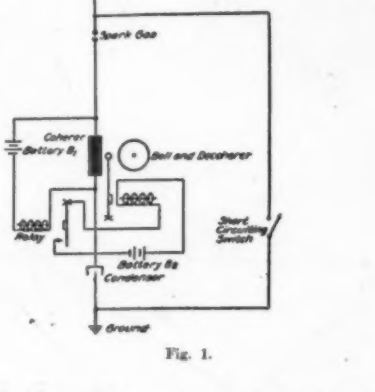


Fig. 1.

Spark Gap.—This consists of a simple gap with spherical terminals placed approximately $\frac{1}{4}$ inch apart. The purpose of this gap is to prevent those surges that are induced in the antennae by the radiations emanating from wireless telegraph stations, but which are very weak as compared to the lighting disturbances, from flowing through the remainder of the apparatus and thus causing a false alarm.

Coherer.—This is also patterned after the type of the simple ones used in the early days of wireless telegraphy. In brief, it consists of a short section of glass tube of small bore loosely filled with nickel-silver filings. These are connected at each end of the outside circuit by German-silver plugs. The action of such a type of coherer is well known and needs no further explanation than to say that it acts as a high resistance to the low-voltage battery current impressed upon it until a high-frequency discharge current, between aerial and ground, has passed through it. This high-frequency current effectively lowers the coherer's resistance to the battery current, which consequently allows a greatly increased battery current to flow through the tube. The resistance of the tube than remains unchanged until it is violently jarred, at which time the high-resistance property returns.

Relay and Battery.—The most effective type of alarm is an audible one, of which the simplest form is a bell. However, as a bell requires a greater amount of current for its operation than that increased amount of battery current which is caused to flow in the coherer by a high-frequency discharge, some magnifying or relay device must be used. The relay employed is one of the ordinary telegraph type and the battery, B_1, Figure 1, is of dry cells. The connections are given in Figure 1.

Bell and Battery.—The bell is one employing single-stroke connections and is of a size sufficient to be easily heard throughout the system operator's office. (The coherer, relay, condenser and bell are located in this office.) The bell has its own supply battery of dry cells, B_2, and is controlled by the secondary contacts of the relay, as shown in Figure 1.

As the low-resistance condition into which the coherer is thrown by a high-frequency discharge is permanent until the tube is severely jarred, the bell is mounted so that its clapper will strike the tube and thus perform the two-fold function of bell and decoherer. (It is evident that the tube must be decohered, otherwise it would not show the effect of a later high-frequency discharge.)

Condenser.—The condenser is an ordinary one and is inserted in the ground wire to prevent stray direct current from flowing in the apparatus.

Ground Connection.—This connection completes the high-frequency circuit from aerial to ground.

The operation of the apparatus comprising the storm detector leaves practically nothing to be desired. The manner in which it enters into the activities of a steam station will be described, as it is perhaps to such a station that it is of the most benefit.

It will be remembered that the bell or decoherer, together with the coherer and relay, are located in the system operator's office.

It is the duty of the system operator that he keep continuously posted on the demands that are or may be made upon the station for power and to so direct the disposal of all the generating machinery that the station will afford the highest quality of service and will operate with the maximum degree of economy. In detail, the latter function he performs by orders to the boiler room specifying how many boilers shall be maintained under load and how many shall be carried "banked," by instructions to the generating room as to which machines shall carry the load and which other units and auxiliaries shall be held idle or in readiness, and by orders to the various switchboard operators as to which feeders shall be used in the disposition of the output.

Under the usual daily conditions of operation the demand which will be made upon the station from hour to hour is accurately known, for the variations of the load curve constitute a daily cycle. These regular changes of load, being anticipated and taken care of by orders from the system operator, become a matter of station routine.

In order to secure smoothness of plant operation, the system operator is informed of the unusual departures from the regular load curve that are to be expected, *e. g.*, exhibition lighting, etc., and also of the weather forecasts. All such is of great assistance in aiding good management. Those unusual irregularities of whose coming he is reliably warned present no difficulties. It has been found by operating experience, however, that the weather forecasts come far from providing a reliable and early warning. Further, the reports are not couched in such terms as furnish the system operator with the information that is of paramount importance to him, viz., the rapidity, in hours, of the approach of the storm.

It is true that the number of severe storms which come over a city with extreme rapidity is much less than that of the slower moving storms, but, on account of their tremendous capacity for suddenly deranging the orderly routine of the lighting station and perhaps even affecting the standard of its service, the fast moving storms make it requisite that all are to be guarded against.

Assume, for instance, such a storm to be approaching a city in which is located a lighting station that possesses a storm detector.

At a time varying from two hours to seven hours before the actual storm clouds reach the city (depending upon whether the path of the storm is a direct or a round-about one), the alarm bell will begin to strike at intervals of from five to fifteen minutes. The system operator regards this merely as the warning of the possible approach of a storm but gives it no further attention, for the storm may change its direction and pass off without molesting the quiet weather conditions of the city.

The disturbing conditions by their further approach cause the bell to ring oftener. With the storm but about two hours' travel away, the bell will strike about once every half-minute or every minute. When this occurs the system operator orders the reserve boilers into service, the auxiliaries of such generating units as he deems may be required started, and the generating units themselves run at low speed.

These conditions prevail until that later time when the bell gives an insistent warning by uniting its periodic strokes into a continuous ringing. This will ordinarily occur at about one-half hour to one hour before the storm

*General Electric Review.

[1]Superintendent Waterside Stations, New York Edison Company.

reaches the city. It has been found quite often that even at this time the sky will remain clear and unclouded to the eye, which shows how much superior are the services of a storm detector to those of a watchman stationed upon the roof to observe the conditions prevailing in the sky. (This latter practice was the best one available prior to the development of the storm detector.) The switch short-circuiting the detector is closed when the bell begins to ring continuously to protect the receiving apparatus, for the storm will now be comparatively close, and to silence the bell for its warnings are no longer needed, since it is positively known by this time that the coming of the storm is a certainty. Simultaneous with this action goes the order to synchronize the incoming generating units with the bus. Everything is now in readiness to supply the increased load which will be demanded in but a matter of minutes.

The following are actual records of the frequency of the bell warnings and the loads existing at various times preceding two storms last year:

July 28th.

1.45 p. m., 1 bell.

2.15-3.30 p. m., 1 bell every ½ to 1 minute.

3.30 p. m., bell began ringing continuously, load 96,000 k. w.

4.15 p. m., (very dark, heavy rainstorm), load 142,600 k. w.

August 1st.

8.25 a. m.-2.00 p. m., 1 bell every three to five minutes.

2.02 p. m.-2.15 p. m., 1 bell every ½ minute, load at 2.00 p. m., 100,000 k. w. (cloudy).

2.15 p. m.-3.20 p. m., bell ringing continuously.

3.45 p. m., load 150,000 k. w.

The storm detector as described is in service and located in the office of the system operator in the Waterside stations of the New York Edison Company. These stations so far as it is known are the only one possessing a device of the same nature.

The field for such a device among steam-driven lighting stations would seem to be in the larger cities, particularly in those which possess crowded office districts as it is the load derived from such a source that is most sensitive to changes in daylight.

A field in which it would also seem that the device would furnish valuable service is that of keeping the isolated hydro-electric station informed as to the weather conditions existing in the distant cities which it is supplying with lighting current. The places of generation and consumption being so far separated, a visual observance of the weather conditions at the power plant would be of no use. By means of storm detectors located in a few of the widely separated towns, which receive lighting current from the station, the attendants may keep forewarned by a bell in their station as to the irregular demands which may be made on them by storm clouds passing over those distant towns.

Some Birds of the Yellowstone*

Unusual Specimens Seldom Observed by Travelers

By M. P. Skinner

We often gain a wrong impression as to the number of birds within Yellowstone Park, thinking them few. Heavy timber is seldom found to be very bird-populous anywhere; and, besides, in the parks the heavy timber is where the stage roads are, and the constant travel frightens the birds away. For these are shy birds, not the half-domesticated ones of the farms and villages. Another reason for the conclusion that birds are few, lies in the fact that the tourist travels during the heat of the day when the birds are resting. Scarcity, however, is more seeming than real; the birds are there—in large numbers. At present 197 species have been recorded. Let the bird-lover go out early and walk along the brush-lined brooks and through the meadows, and he will find birds in plenty. To be sure, there will not be as many as in a cultivated section; there never are. The cultivated area has too many attractions in the way of grains, fruits, and insects.

Usually the first bird noticed in the Yellowstone is one that is small and almost black, flying along close to the surface of a stream. He tries to alight on a slippery rock, slides off into the water, unconcernedly paddles ashore, and climbs out. A close scrutiny shows this oddity to resemble a wren, except that he is darker, and has feet of ordinary passerine construction and not webbed. He is the dainty little "dipper," or "water ouzel," of the mountain streams. If you watch him, he does still more curious stunts. He sits on a stone for a few moments, only his white eyelid moving; then comes to life, bows first toward you, then turns and repeats his curtsy in the opposite direction, walks down the rock into the water, under the water, and across the pool bottom, stopping here and there for a moment, and finally comes shooting up to the surface as buoyant as a cork. No misanthropic hermit is the dipper. True, he lives alone with his family on his own section of stream, which he is always ready to clear of poachers by force of bill and wing, but he picks out the true scenic parts. A waterfall is a favorite dwelling place, and I have never found the nest anywhere but near rapid water. Usually a rock in midstream is selected and the nest placed so that it is directly above the water, the opening downstream. Both birds work hard at building the nest—a ball eight inches in diameter, made of a peculiar kind of moss and fastened in a crevice or notch in the rock with a cement of mud. The ball is lined with mud, and the inner nest constructed of fine, waterproof grass that will not become sodden. The spray from the rushing water keeps the moss green, and during the summer grass seeds are sure to lodge on the ball and sprout there, so that the nest soon resembles a small clod of earth supporting a tuft of luxuriant grasses. The entrance to the nest is usually arched over, or bottle-necked with opening downward, to shed the spray. The brainy little architect waits until after the June freshets before building a nest—which might be inundated earlier. He really seems to wait, for he mates early, after having sung his dainty little song since Christmas. One of the strangest facts in nature is that this tiny bird is a *winter* songster. He is not just a mere chirper, his notes are varied and unusually sweet. Often he is heard in the depths of a wintry world, when his song rings out above the noise of such rapid waters as are open in January.

Barely has one crossed the norther boundary of Yellowstone Park, before the driver points out Eagle Nest Rock, and the "eagle's" nest on it, but the birds nesting there are actually ospreys. Eagles, both golden and bald, are resident in Yellowstone, build their nests and raise their young there. They are so scarce, however, as to be rarely seen, whereas the ospreys are conspicuous along every large stream. They are found by hundreds about Yellowstone Lake and Cañon. One who has watched and studied the osprey, finds him a far nobler bird than either of the eagles. The golden eagle is a fine bird and usually captures his own prey, but the osprey will touch nothing but fresh fish of his own catching. The bald eagle, unfortunately chosen our national bird, is a robber and a carrion-feeder. He watches the more expert osprey, and when the trout has been secured, he torments the smaller bird until it drops the fish. Then with an exultant scream, the eagle swoops down and catches up his unlawful prey. Often the bald eagle is ignobly caught in a coyote trap set near a dead elk. The osprey is a far different bird, cleanly in his habits—and his young are the models of deportment among birds.

The original nesting site of ospreys in Yellowstone was the tip of a pine or fir, where a great mass of sticks six feet or more in diameter was deposited, at times a stick as large as a man's wrist being used. About Yellowstone Lake there are literally hundreds of these nests. In various other parts of the park, however, notably in the Yellowstone and Gardiner cañons, the osprey has found the pinnacles of out-jutting rock adapted to his purpose, and builds his nest and raises his young there, to the delight of thousands of visitors who can look down upon the family. I cannot confirm other writers in their reports that the ospreys repair their nests in the fall; they may do so. I have repeatedly seen them rebuilding and repairing in April and May, however, when they first return from the south. As a rule the same birds return to a given nest year after year. After the eggs are laid, the mother broods them for four weeks. I do not believe that the male makes it a rule to relieve her, but he does do the hunting and is very conscientious in seeing that she gets her share. Occasionally when the sun is warm, the female gets away from the nest for a short time. The two or three young are hatched so tender that the mother remains on the nest to shield them from the sun with her half-opened wings. When the father brings in a fish, from which he has first removed the head and entrails, there is none of that hurly-burly so characteristic of other birds. The youngsters sit in an orderly row, without any attempt to get the fish, perhaps within three inches of them. The father stands on the trout, tears off half-inch bits which he gives to the mother, she "chews" them a few seconds and then gives some to each nestling in turn. Sometimes the male turns the catch over to the female, letting her do all the tearing and feeding; and he occasionally feeds a bit directly to a youngster. Not only at feeding time do the young ospreys show their training. Let an enemy appear, a warning note is sounded by a parent, usually the mother, and the young instantly throw themselves flat on the floor of the nest and remain there motionless. Should one be picked up, he is like a lump of putty and can be placed in any posture. Nothing but the parent's cry of "All's well," perhaps not given until an hour or more after the warning, will bring him back to the semblance of a living bird.

The mountain bluebird is of a beautiful blue, indeed; even the breast is blue instead of the chestnut of the eastern bird. This bird is not quite so domesticated as the better known species, but otherwise is much the same. About the few buildings in the Yellowstone the bluebird nests as fearlessly as about an eastern farm; but buildings are scarce, and many bluebirds still follow their old-time plan of building a nest in the trunk of a quaking asp. It is a pretty sight to see a pair hunting a nesting place in early May. The husband is the scout: he goes ahead and locates a likely tree with an old woodpecker hole in it. Then he brings his wife, no doubt telling her how superior the tree is to all other trees, and the neighborhood to all other neighborhoods, and perhaps calling attention to the running water in the near brook. She hovers for a few minutes in front, looking the opening, the tree, and the neighborhood all over, and when she makes up her mind it is final. Should it be "No," the husband does not sulk but immediately hunts another tree over which he is just as enthusiastic. Should the answer be "Yes," they both set to work to collect materials; but I believe that she places most of it while he cheers her on with his gentle love song. When the bairns arrive, all is hustle and bustle. For a time, I do believe that they are the busiest parents alive. Vast, indeed, is the number of grasshoppers and caterpillars caught to satisfy that hungry nestful.

At the other extreme is the nutcracker, or Clark's crow; nothing soft, nor gentle, nor musical about him! But perhaps our ears are not properly attuned to appreciate the rolling "c-crack-k-k-k" with which he announces his presence. His uniform of gray with flashes of black and white is neat and attractive, and his ready adaptability to conditions should win our respect. This species seems more abundant about Mammoth Hot Springs than anywhere else; presumably the large supply of pine cones, as well as the kitchen scraps, draws the birds there. Sometimes the nutcracker, by a swift, sudden swoop, robs a squirrel of his cone. The squirrel may be knocked from his perch, but even if he keeps his footing he is almost sure to drop the cone. A sudden dive and the nutcracker has it, perhaps before it touches the ground. Now the pine squirrel, himself, is an impudent fellow, a noted thief and robber; but well he knows that the bird can best him. He sneaks back to some protecting cranny and then proceeds to enliven the woods by the vituperation he hurls at his enemy; and that enemy is not slow to give back his unfavorable opinion of squirrels in general, and of that squirrel in particular. I am sure that I should not dare to attempt a translation of those vitriolic remarks.

Impudent rascal and freebooter that he is, the nutcracker is never quite so happy as when a fight is going on. I even suspect him of engineering difficulties for other birds. One day two little mountain bluebirds got into an altercation. They were hard at it, when the nutcrackers began to arrive, screaming. One became so excited that he flew into a wire fence and partially

*From the *American Museum Journal*, published by the American Museum of Natural History, New York.

stunned himself. Nor does the nutcracker always confine his attentions to small birds. Mobbing hawks seems to be a favorite amusement. If the hawk is big and clumsy, so much the better. But it is the breeding habits chiefly that make the nutcracker interesting. February is the height of winter in the Yellowstone, the nights are intensely cold, and the snow still lies deep everywhere. Yet the nutcrackers mate then and build a nest of cedar twigs and such straws as can be found above the snow. Frequently the eggs are laid during the last days of February and brooding begins immediately. I have seen the mother on the nest when the thermometer was below zero, and at other times during a raging blizzard. The young birds are out of the nest and flying about May 1st, before most other birds have begun to nest.

It is the Rocky Mountain jay that is beloved of the camper. This bird, known as the "camp robber," although he scavenges rather than robs, is closely related to the nutcracker. He bears a superficial resemblance to that bird, but is smaller, of a gray color without the black and white markings of the other, and his calls are different. The "camp robber" is bold and fearless without the impudent, noisy ways and pugnacious proclivities of the nutcracker. At camp he is always about, always getting into trouble, and always trying to share the camper's good things with him. He claims his share, perhaps because he is socialistic and believes the camper should divide his goods. If the camper is hard-hearted, or even slow, the jay will tell him all about how hungry he is, how scarce food is, how "high the cost of living" is getting, and end his appeal in the most coaxing, wheedling tones imaginable. Hard-hearted, indeed, is he who can resist this daring little beggar. He is into everything, he knows no fear. It is not safe to take a pot or a pan off the fire and set it down to cool—the "camp robber" is watching for just such chances. But he more than makes up for the crumbs and scraps by the companionship he affords.

Perhaps the most astonishing thing about the Yellowstone birds is the friendliness of the ducks and larger waterfowl. It is often hard to believe that the ducks feeding with a few feet of the passing stages are actually "wild." This tameness is not any more peculiar to the Yellowstone, to be sure, than to other absolutely protected places. It is interesting to see how shy the migrating ducks are when they arrive, and how soon they lose their wildness and adopt Yellowstone ways. The mallards are to be found on or near most of the ponds and smaller lakes, usually with a half dozen fuzzy little ducklings following the mother about everywhere. Although the little chaps are expert hiders and dodgers, there is no doubt that the fierce duck hawk and the large owls get a good many. On land they are subject to attack by wolf, coyote, bobcat, and a whole host of smaller fur-bearing animals. Even in the water there is an enemy. I was riding past a pond and noticed a brood of ducklings swimming. They were sunning themselves, and occasionally chasing a venturesome bug across the surface. Apparently they were carefree and safe. Suddenly the mother sounded a note of alarm and made for the farther shore with the whole brood after her. Soon a muskrat appeared swimming rapidly toward the ducks. How they did swim! Not fast enough, although they used their stubby little wings to help them along. The muskrat was almost upon the duckling in the rear, when the mother saw the danger and in an instant was there scooping water with her wings into the rat's face. This secured delay enough to let the duckling gain a lead. Soon the race was on again and the enemy was getting uncomfortably near. The mother drove him off a second time, and yet a third time, before she had her brood safe on shore.

Some of the big Canada geese stay in Yellowstone Park all winter, finding favorable conditions along the rivers kept open by the hot-spring water. But most of them arrive from the south in early April, and then the ponds and flooded meadows are a riot of noise. The "honk-ah-honk" of geese flying far up overhead is a silvery, musical note; but heard near at hand, especially on a cold, stormy morning when the tired camper is trying to sleep, it arouses other feelings than appreciation of musical quality. Geese are long-lived and are believed to mate for life, yet every spring they become as restless and ardent as any of the courting song birds. After the selection of the nest site, usually the top of a beaver house, a rock surrounded by water, or a low mound of some kind, the birds settle down and give their whole attention to important affairs. There is no nest building beyond lining a slight hollow with a few feathers from the goose's breast. About eight eggs are laid and the goslings appear late in May. It is amusing to see the old goose swimming across a pond with her little ones strung out at regular intervals behind—just as if she were a tugboat towing a string of barges. About four hundred pairs of geese are believed to nest within Yellowstone Park. Like the mallards, the geese become very tame, and are an unfailing source of interest.

I know of no place where protection makes the big hawks as tame and as easily studied as in Yellowstone. Ordinarily hawks are so hunted and harried that the bird-lover must devote considerable time to them before he can say he knows them. Here everything helps the acquaintance. Few of us have much love for the fierce accipitrine hawks, but fortunately these are rare. The western red-tail is the largest hawk, but he does even less damage than his eastern relative, and confines his attentions almost exclusively to gopher and ground squirrel. It is Swainson's hawk that upsets one's preconceived notions of hawks. This species is nearly as large as the red-tail and much more numerous, enough so in the open country to be called abundant. Even the timid little wood warblers have so much confidence in this big rodent catcher that they fly fearlessly all about him and even nest in his immediate neighborhood. Both this hawk and the red-tail vary much in color, from reddish brown to almost black. The marsh hawk is guilty elsewhere of killing small birds, but in the park he too is on his good behavior and devotes his time to mice with an occasional frog or small snake for relish. He is a pretty chap when seen just skimming the brush tops on his way to and fro across the meadows. In places like the Pelican and Hayden valleys, the marsh hawk is astonishingly abundant. It is the little sparrow hawk, however, that attracts the most attention. He does not get up into the elevated sections nor into the timber, but often he is the only animated thing to be seen as we ride through the lower, warmer, open country.

In the southeastern part of Yellowstone Lake are two small islets known collectively as "Molly Island." They are low and consist of sand and gravel with only a few bedraggled bushes, but the big white pelicans find them a suitable nesting place. There every summer about two hundred pairs of these birds lay their eggs and raise their ungainly, unlovely offspring. Molly Island is almost ideal for them; it is secluded in a long, sheltered arm of the lake, yet is far enough from shore to prevent predacious animals from getting to the young birds; also the waters abound in fish, the food of the pelican. In former years, these birds nested as far east as the Dakota lakes, but the steadily advancing civilization has driven them farther and farther west until these little islands are their "farthest east." The pelicans are expert fishermen and their search for prey carries them to all parts of the lake and even down the Yellowstone River below the lake. From the boat that carries passengers across, at least one pelican is invariably seen and the cry "Swan! Swan!" is always raised. This is not so surprising an error, since the birds are large and white, and make very conspicuous objects as they move majestically over the water. In flight pelicans are still more striking in appearance. A single one flying past is a sight to be noted, so white, so large, so strong and graceful. If a small group of them passes, it will be seen that they are flying in line, each pair of black-tipped wings stroking in perfect time with the leader. Then follows a short glide on set wings, which is broken first by the leader, the second bird takes up the stroke, and after an interval as accurate as if timed, the third one joins in. But to see these wonderful flyers at their best, one must go to the southern end of the lake. At certain periods during the day the males relieve their mates on the nest, and then the arriving and departing birds are in squadrons that wheel and maneuver with wonderful precision. To see a flock of a hundred of these great, swift-moving, gleaming-white birds against an intensely blue sky is the sight of a lifetime. It is a picture well calculated to remind us of the wonderful series of birds and animals that has been ours in North America in the recent past; and it can but interest us greatly in the work being done by the United States Government, through the National Parks, in preserving parts of our elsewhere-squandered inheritance.

Earthquakes More Frequent at Night

It is an established fact that earthquakes are more frequent in California during the night than during the daylight hours. This is all the more evident when it is recognized that in small communities slight disturbances occurring at night when most people are soundly asleep may pass entirely unrecorded. During 1916 the time of occurrence was determined in 63 earthquakes. Of these, 27, or 43 per cent, occurred during the daylight hours, 6 A. M. to 6 P. M., and 36, or 57 per cent, during the remaining 12 hours. A study of 1,405 California earthquakes which occurred during 147 years from 1769-1915 inclusive, showed exactly the same distribution. While this is apparently another singular coincidence, it is worthy of mention.—From a paper by A. H. Palmer on California Earthquakes during 1916 in *The Bulletin of the Seismological Soc. of Am.*

Providing for Braking Stresses on the Quebec Bridge

The long suspended span of the Quebec Bridge, 640 feet between pins, will be subject to a sudden movement, over the 17-inch leeway provided, when brakes are applied to a high-speed train passing over it. In order to restrain this influence a traction brake is provided at the end of the cantilever arms. This brake is made up of a series of plates that slide between each other and are kept in contact by a set of car springs under a constant compression. Every alternate plate is fixed by a pin at one end to the horizontal piece of chord at the end of the cantilever arm and has a slotted hole at the other end to allow the necessary motion on the pin, which fixes the remaining sliding plates to the suspended span. These remaining plates are slotted in a similar manner, so as to allow the same amount of motion on the pin connecting the first-mentioned plates to the cantilever arm.

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